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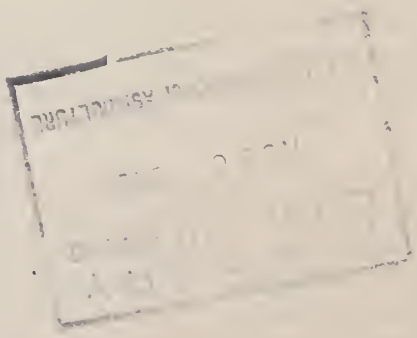

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AIC-249
June, 1949

UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural and Industrial Chemistry
Agricultural Chemical Research Division
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New Orleans, Louisiana

REPORT OF STUDIES ON THE UNIFORMITY OF QUALITY OF BEET SUGARS, NO. XXVIII.

1. Chemical and Physical Studies on the Beet Sugars of the 1948 Campaign, by C. A. Fort.

2. Biological Studies of the 1948 Beet Sugars, by H. H. Hall and Dorothea J. Teunisson.

REPORT NUMBER XXVIII

A Review of the Operating Data of the 1948 Campaign and of the Chemical, Physical, and Biological Studies of the Sugars Produced.

PREFACE

Seventy-one of the domestic beet sugar factories operated during the 1948 campaign. Four of these had a double campaign. Twenty-nine used the Steffen process and one used ion-exchange demineralization. The beets sliced per factory ranged from 25,000 to 516,000 tons, the average per factory being 129,527 tons. Molasses Steffenized amounted to 257,383 tons.

All factories submitted campaign composite sugar samples for analytical examination. Seven additional samples were included in the studies but were not included in calculating the average values shown in some tables.

In Part I is presented a tabular summary of operating data supplied by the factories. The beet polarization and diffusion juice purity data include the low, high and mean values for the years during which this sugar quality report has been prepared. The chemical and physical test results on sugars in many cases show the low, high and mean values for the past nine years of the report. In Part II are summarized the microbiological data obtained on the sugars.

Again acknowledgment is made of the excellent cooperation of factory chemists in supplying the operating data and sugars.

This is the final sugar quality report to issue from the Agricultural Chemical Research Division of the Southern Regional Research Laboratory so the sugars of the 1949 campaign should not be sent to this office.

PART I

OPERATING DATA FOR THE 1948 CAMPAIGN AND CHEMICAL AND PHYSICAL STUDIES OF THE SUGARS PRODUCED

By C. A. Fort

A. Factory Operating Data

(1) Quality of beets and diffusion juices (Table 1). As this is the final report it seemed desirable to review the data of past years in respect to the polarization of the beets and purity of the diffusion juices. The comparative data are given in the first table. The year index is omitted from the key numbers and a few factories are included which did not operate in 1948. The current values are given in columns headed 1948.

Fourteen factories had the lowest sucrose in beets and 12 had the lowest diffusion juice purities of any year for which there is a report. Only one factory had the highest sucrose of their record although ten experienced the highest juice purities. The low, high, and mean values would not correspond to the longer term data available at some factories. Some records only go back for 9 years or less and none are available before 1932, however, it is felt that values for 9 or more years are representative and give a basis for comparison with future crops.

While there is obviously less contrast between the long-time means for the different factories than between the values for a single year, still the range of 14.5 to 18.4 in polarization means and that of 81.1 to 89.7 in purity means indicate consistent pronounced effects of climate and environment on beet quality. The degree of variation between different years at particular locations, during the 17-year period, was as little as 2.0° in polarization and 2% in purity. However, at other factories the extremes between years differed by as much as 5.5° in polarization and 7.5% in purity. Naturally it was the humid production areas which showed the greater year to year variation and the arid irrigated areas the smaller deviations in beet quality.

The primary effect of beet quality is on the relative yields of sugar and molasses rather than on sugar quality. Processing techniques tend to produce sugars of similar quality year after year regardless of beet quality. In spite of this adjusted processing there are effects on the composition and quantity of impurities in the sugars which are directly related to the nonsugar composition of the beet juices characteristic of the different producing areas.

It is to be noted that the mean polarization for the 1948 campaign was about 0.5° below the long-term average. But juice purities were average and therefore better than might be expected from the polarization values. It is generally considered that purity and polarization are fairly well related, and this may be true in comparing samples of different maturity from the same field and possibly even when comparing different fields in the same area. However, when the data of table number 1 are arranged in order of purity, it is found that in comparing different locations or areas the juice purity is not necessarily high when sucrose is high

TABLE 1. BEET AND DIFFUSION JUICE QUALITY

Key No.	No. of Years on Record	Beet Polarization				Diffusion Juice Purity			
		Low	High	Mean	1948	Low	High	Mean	1948
1	15	14.6	16.7	15.63	16.35	84.6	88.6	86.47	88.6
2	15	15.8	19.6	17.90	17.56	84.1	87.1	85.36	85.0
3	15	13.9	17.1	15.33	13.85	85.6	87.8	86.73	86.3
4	17	14.7	18.8	16.08	18.36	83.2	88.0	85.89	87.4
5	15	14.2	18.0	16.19	14.23	84.3	88.3	86.65	84.9
6	13	15.6	17.8	17.42	16.52	80.5	86.9	84.66	84.1
7	12	16.1	18.5	17.40	16.06	87.7	89.2	88.57	87.7
8	16	15.7	17.6	16.68	16.34	87.9	90.2	88.73	88.0
9	13	13.3	17.9	15.43	16.18	81.1	87.2	84.98	86.7
10	9	14.7	17.8	16.06	15.49	86.0	88.9	87.98	87.4
11	9	13.2	16.7	15.12	13.98	84.4	87.1	85.73	85.8
12	10	15.7	17.2	16.45	---	86.6	90.1	88.75	---
13	15	14.9	18.2	16.17	18.08	85.1	90.1	87.56	90.1
14	17	14.9	17.0	15.98	15.74	84.8	87.7	86.39	86.7
15	17	12.7	16.6	15.13	16.62	81.9	87.1	84.85	87.0
16	12	16.0	18.2	16.95	16.03	85.2	87.4	86.54	85.6
17	14	15.3	18.8	16.99	15.25	84.8	87.7	86.61	84.8
18	9	15.0	17.6	16.57	17.04	87.7	89.3	88.32	89.3
20	17	15.4	17.9	16.83	16.57	86.9	89.8	88.32	88.3
21	16	14.2	18.3	16.38	16.91	84.3	87.7	85.58	86.8
22	17	13.3	17.6	15.42	14.40	84.3	88.1	86.33	86.0
24	15	14.2	17.3	15.62	15.18	85.0	88.3	86.93	87.7
25	11	14.6	17.3	15.74	---	85.4	88.4	87.56	---
26	10	13.5	17.3	14.98	14.42	83.5	87.1	85.91	86.2
27	15	13.0	17.9	15.67	16.20	79.6	87.1	84.58	87.1
28	16	12.5	16.5	14.64	13.23	77.7	83.4	81.09	79.4
29	14	14.7	17.0	16.06	15.19	85.3	88.3	86.93	85.5
30	17	12.4	16.7	14.86	12.41	82.7	86.8	85.52	83.1
31	17	13.5	16.1	14.84	14.85	79.9	86.7	84.25	86.4
32	17	13.8	18.0	15.56	14.81	85.5	88.9	87.15	87.5
33	15	14.2	17.0	15.81	16.60	83.9	87.6	85.76	85.6
34	10	14.4	16.9	16.15	14.39	82.5	85.9	84.57	82.5
35	12	14.7	18.0	16.43	14.73	85.0	88.4	86.33	85.0
37	17	15.8	18.1	16.68	16.04	87.9	91.8	89.65	88.9
39	16	14.5	16.9	16.00	15.75	84.5	88.7	87.43	88.6
40	17	14.9	17.1	15.94	15.70	85.2	88.0	87.03	86.5
41	9	14.6	17.7	15.84	14.77	86.0	88.2	87.46	86.8
42	9	14.3	17.7	15.78	15.15	86.3	88.5	87.81	87.8
43	16	16.3	19.4	17.67	16.25	87.9	89.7	88.74	88.7
44	5	13.5	16.5	14.46	13.53	84.8	87.5	85.56	84.8
45	13	15.2	18.4	16.96	15.44	84.1	87.7	85.62	84.7

(continued on next page)

TABLE 1. BEET AND DIFFUSION JUICE PURITY (Continued)

Key No.	No. of Years on Record	Beet Polarization				Diffusion Juice Purity			
		Low	High	Mean	1948	Low	High	Mean	1948
46	17	12.7	16.9	14.98	16.42	80.9	88.0	84.85	87.5
47	15	14.2	17.9	15.75	16.14	83.3	86.2	85.15	84.5
49	17	16.1	18.7	17.35	16.78	87.7	90.6	89.29	90.0
50	9	14.0	16.5	15.28	14.20	86.5	88.5	87.42	86.9
52	12	14.7	17.2	16.14	---	85.1	88.5	86.86	---
53	11	15.1	16.8	16.04	15.63	86.7	90.7	88.37	90.7
54	7	15.4	16.8	16.09	15.64	85.6	89.9	87.77	89.9
55	15	12.5	17.8	15.08	16.91	79.2	86.8	83.05	86.1
56	17	13.3	16.9	15.19	13.25	82.4	86.0	84.69	82.4
57	17	15.5	19.3	17.39	17.03	84.6	88.1	86.04	84.6
59	17	16.0	17.9	16.76	16.15	87.4	89.5	88.40	87.4
60	17	13.8	17.2	15.50	14.75	81.6	89.2	87.08	89.2
61	11	15.7	17.2	16.32	15.92	86.1	89.8	88.28	86.1
62	13	14.2	17.6	15.38	16.57	83.9	89.4	86.80	88.3
63	17	14.7	17.5	15.78	16.38	84.4	87.6	86.15	86.5
64A	11	16.8	19.8	18.44	17.54	82.6	86.7	85.19	84.6
64B	12	13.8	19.4	16.47	15.48	79.6	84.1	81.67	82.0
65	17	13.9	17.7	15.55	13.93	85.3	88.5	86.62	85.4
66	17	15.4	18.9	16.65	18.47	84.4	90.6	87.71	90.6
68	13	15.1	18.0	16.59	---	85.0	88.9	87.35	---
69	12	15.2	17.7	16.47	15.23	84.5	87.2	85.84	85.4
71	15	15.7	18.1	17.37	15.67	85.1	88.8	87.62	86.6
72	17	13.6	17.2	15.26	13.62	84.1	87.5	85.53	84.3
73	16	14.1	16.9	15.50	15.03	83.7	88.7	85.78	87.1
75	17	13.5	16.9	15.37	15.16	80.5	86.1	84.25	85.4
76	12	14.5	16.6	15.71	15.71	82.4	88.9	87.95	88.9
77	17	14.3	18.2	16.11	14.30	84.1	87.0	86.03	85.7
78	17	13.9	18.5	15.79	15.02	81.8	85.7	83.84	83.4
79	14	15.3	18.8	16.41	15.27	85.6	89.8	88.21	89.8
80	15	13.8	17.1	15.75	15.27	83.1	87.9	85.87	83.1
82	9	13.8	17.4	15.21	14.72	86.2	88.8	87.42	87.2
83	12	15.2	17.9	16.57	15.69	84.9	87.7	86.64	84.9
84	12	15.8	17.7	16.55	15.87	87.1	89.3	88.22	88.4
85	1	—	—	—	17.29	—	—	—	84.1
86	1	—	—	—	17.49	—	—	—	85.4
91	6	15.3	18.0	16.52	16.99	86.4	89.8	88.17	89.8
93	2	15.7	17.0	16.33	16.96	84.7	87.5	86.10	87.5
94	8	16.9	18.5	17.60	17.19	87.3	89.5	88.59	89.0
95	8	16.7	18.3	17.54	17.23	87.4	88.9	88.30	88.7
Average 1/		2/ 14.5	18.4	16.05	15.57	81.1	2/ 89.7	86.40	86.46

1/ Excluding Nos. 12, 25, 52, 68, 85, 86, 91, 93, 94, 95.
2/ Low and high of means.

nor low when sucrose is low. As an extreme example the highest mean purity and the next to the lowest purity only differed by 0.2° in polarization. The values referred to are a purity of 89.6 with a polarization of 16.7 and a purity of only 81.7 with polarization of 16.5. These are long-term average values and indicate what extreme effects soil and climate have on beet quality. Again, the lowest mean polarization, 14.5 showed a purity of 85.6; yet at another location the mean polarization of 18.4, which is the highest of any, had a purity of 85.2. It is, therefore, quite evident that diffusible nonsugars can show wide deviation independent of the concentration of sugar.

While not tabulated in this report a calculation was made of the approximate diffusible nonsugars and of their ratio to polarization. These values of diffusible nonsugars, as percent on polarization, showed a regular and almost completely consistent increase with decreasing purity. The lowest amount, 11.6%, corresponded to the highest mean purity and the highest, 23.3%, resulted from the lowest purity. The contrast in processing difficulties and yields at these two locations is extreme but the beets at half of the factories fall in the range of 15 to 17% nonsugars on polarization.

(2) Juice clarification (Table 2). The data presented in this table for 1948 are much as for past years. The soda ash used decreased at non-Steffen and increased at Steffen factories. Alkalinities after carbonation were normal. The sulphur used was essentially the same as for 1947, a rather low value compared with the previous campaigns. Again one factory did not use sulphuring and several used very small amounts.

(3) Thick juice processing (Table 3). Thin and thick juice pH tended to be very slightly higher than for the 1947 campaign. The increase in pH due to evaporation to thick juice was essentially the same as last season in non-Steffen operations; but Steffen juices showed a slight drop in pH instead of a similar increase. The lime rating which combines the lime salts and soda ash used (see report for 1946 No. XXVI, page 8) indicates a decided drop in the tendency to form soluble lime salts at the non-Steffen factories; but the corresponding Steffen value was only slightly below last season. The low lime salt averages approximated those reported in 1945.

There was a slight increase in both the filtration Brix and purity of the standard liquor over the last campaign. Filtration was made at over 61° Brix at all except 2 locations, and in 8 instances the Brix was 70° or over. The temperature of filtration was also slightly higher. The filter-aid used at non-Steffen factories averaged higher than last season but for the Steffen factories the value was lower than any year since 1944.

(4) White sugar processing (Table 4). The mean values for white masse-cuite purity are slightly higher than for the 1947 campaign. Nearly one-third of the purities were over 93% which is a greater proportion and number than usual. The means for pH, Brix, and cubic feet of masse cuite yielding 100 pounds of sugar, are not significantly different from normal.

The water used in white sugar washing shows a decrease, especially at the Steffen factories. High-wash purities increased for non-Steffen but not

TABLE 2. CLARIFICATION OF JUICES

(A) Non-Steffen Operations (1948)

Key No.	Lime Used on Beets	Soda Ash per Ton Beets	Sulphur per Ton Beets 1/	Carbonation Data			
				First		Second	
	%	lb.	lb.	pH	Alkalinity	pH	Alkalinity
4801	2.26	0.11	*0.42	—	0.075	--	0.018
4803	1.54	0.41	0.48	11.1	0.075	9.4	---
4804	3.00	none	* 0.22	11.0	---	9.2	---
4805	1.93	none	0.42	10.7	---	9.0	0.017
4806A	2.91	--	0.20	--	0.081	--	0.015
4806B	2.75	--	0.16	--	0.088	--	0.015
4808	1.60	0.02	0.23	--	0.079	9.1	---
4809	3.60	none	none	--	0.079	--	0.013
4810	1.19	none	0.41	--	0.075	9.3	---
4811	1.19	0.03	0.50	--	0.082	9.4	---
4813	1.85	--	* 0.26	--	0.069	--	0.012
4814	1.87	0.03	0.36	--	0.081	--	0.018
4815	2.18	0.12	0.63	10.7	0.077	8.9	0.017
4816	1.94	none	0.32	--	0.083	9.1	0.018
4817	2.76	0.36	0.40	10.6	0.078	9.0	0.022
4818	2.06	0.20	0.40	--	0.079	--	0.014
4821	2.71	0.11	0.63	10.6	0.086	8.9	0.018
4822	1.35	0.19	0.37	--	0.078	9.4	---
4827	2.96	0.06	* 0.09	--	0.073	9.1	---
4832	1.26	0.01	0.45	--	0.084	9.6	---
4833	2.50	none	0.87	--	0.075	--	0.026
4834	3.00	0.43	0.30	--	0.076	8.9	---
4835	1.87	0.28	*0.24	--	0.070	9.5	0.018
4839	2.07	none	0.30	--	0.082	8.9	---
4843	1.27	0.02	0.40	10.9	---	9.1	---
4844	1.70	none	0.67	11.2	0.077	9.5	---
4845	2.57	none	0.15	--	0.084	--	0.015
4847	2.70	0.52	0.12	--	0.065	--	0.017
4849	2.26	none	0.68	11.1	---	9.7	---
4850	1.65	0.14	0.57	11.4	0.073	9.9	---
4854	1.98	0.72	0.46	--	0.061	9.2	0.021
4855	3.20	0.05	0.25	--	0.048	--	0.016
4859	2.67	none	0.80	--	0.084	9.3	---
4861	1.98	0.19	0.66	--	0.071	9.4	0.022
4863	3.17	0.51	*0.18	11.3	---	9.7	---
4866	1.75	0.49	*0.25	--	0.078	--	0.016
4869	2.09	0.21	0.46	--	0.074	9.4	---
4873	2.11	none	0.33	--	0.076	9.3	---
4876	1.93	0.55	0.23	--	0.081	--	0.016
4880	1.47	0.02	0.25	--	0.077	--	0.016
4882	1.29	0.08	0.42	11.4	---	9.3	---
4885	3.02	0.44	0.41	--	0.070	8.9	---
4886	2.86	0.72	0.57	10.6	0.089	9.0	0.022
4891	1.93	none	0.25	--	0.090	--	0.017
4893	2.79	none	* 0.37	10.8	0.074	8.8	0.014
4894	2.49	0.007	* 0.38	--	0.077	--	0.013

(continued on next page)

TABLE 2. CLARIFICATION OF JUICES (Continued)

(B) Steffen Operations (1948)

Key No.	Lime Used on Beets	Soda Ash per Ton Beets	Sulphur per Ton Beets 1/	Carbonation Data First		Carbonation Data Second	
	%	lb.	lb.	pH	Alkalinity	pH	Alkalinity
4802A	5.05	1.45	0.17	—	0.062	9.0	---
4802B	4.29	1.33	0.11	—	0.061	9.1	---
4807	2.41	0.40	0.29	—	0.070	9.2	---
4820	2.97	0.02	* 0.36	--	0.078	9.1	---
4824	3.24	0.03	0.48	11.2	---	9.3	---
4826	2.75	0.82	0.34	11.1	0.076	9.4	---
4828	4.77	0.51	* 0.31	—	0.050	8.1	---
4829	3.60	0.48	0.28	—	0.081	—	0.016
4830	2.69	0.34	0.68	11.0	---	9.4	---
4831	3.26	0.08	0.50	10.8	0.082	9.2	0.025
4837	2.80	0.44	0.19	--	0.075	9.0	---
4840	3.94	1.24	0.70	--	0.061	9.4	---
4841	2.82	0.08	0.37	--	0.075	9.3	---
4842	3.08	0.70	0.37	—	0.077	9.3	---
4846	3.01	none	* 0.56	10.4	0.074	8.6	0.018
4853	2.98	1.30	0.40	—	0.062	—	0.022
4856	2.39	0.73	0.53	10.0	0.069	9.6	---
4857A	5.02	1.72	0.82	10.6	0.070	9.1	0.017
4857B	4.51	3.13	0.69	—	0.087	--	0.018
4860	2.84	none	0.51	11.1	0.070	9.1	0.014
4862	3.02	0.03	* 0.42	11.1	---	9.0	---
4864A	—	0.94	0.16	—	0.078	9.0	---
4864B	3.78	1.54	0.16	—	0.080	9.0	---
4865	2.82	—	0.40	11.2	---	9.3	---
4871	4.02	0.71	0.19	9.6	0.075	8.9	0.025
4872	3.20	0.52	0.56	11.0	0.065	9.5	---
4875	3.18	none	* 0.39	—	0.071	9.2	---
4877	3.71	none	* 0.43	—	0.083	9.0	---
4878	4.19	0.90	0.20	--	0.073	9.0	---
4879	2.52	1.49	0.47	—	0.061	—	0.016
4883	3.87	0.46	0.11	—	0.85	—	0.018
4884	3.26	none	* 0.53	—	0.081	9.0	---
4895	2.85	0.10	* 0.39	—	0.094	—	0.012
Mean A	2.19	0.173	0.384	11.0	0.077	9.25	0.0175
Mean B	3.42	0.690	0.396	10.75	0.073	9.12	0.0189

1/ Numbers 4804, 4827, 4828, and 4863 sulphured thick juice only. Numbers marked with an asterisk sulphured both thin and thick juice. The rest sulphured thin juice only.

TABLE 3. THICK JUICE PROCESSING

(A) Non-Steffen Operations (1948)

Key No.	Thin Juice pH	Thick Juice pH	Standard Liquor or Blow-Up				
			Lime Salts	Purity	Filtration Data		
					Brix	Filter-aid used per ton beets	Temperature
			%	%	0°	Lb.	C°
4801	8.7	8.6	0.077	93.5	63.9	0.61	92
4803	8.2	8.4	1/ 0.041	90.7	68.3	0.47	87
4804	9.2	9.6	0.026	93.2	63.2	0.94	89
4805	8.2	9.5	0.027	91.9	66.2	0.57	93
4806A	8.7	8.0	0.060	91.9	67.3	0.80	90
4806B	8.7	8.0	0.031	92.3	66.9	0.64	90
4808	8.2	9.0	0.099	92.3	68.3	0.64	98
4809	8.8	9.8	0.014	91.7	66.3	0.52	92
4810	8.1	9.4	1/ 0.018	91.4	68.1	0.28	88
4811	8.2	9.1	1/ 0.041	90.0	70.0	0.22	90
4813	8.3	8.2	0.061	93.8	62.5	0.49	102
4814	8.4	9.3	0.045	91.0	67.6	0.55	94
4815	8.1	9.0	0.064	93.0	61.4	0.89	93
4816	8.5	8.7	0.056	91.7	70.0	0.45	97
4817	8.4	7.5	-----	92.5	65.7	0.88	93
4818	8.8	9.0	0.037	93.7	60.9	0.72	95
4821	7.7	8.0	0.052	92.2	67.9	0.83	92
4822	7.9	9.3	1/ 0.027	90.5	69.3	0.35	92
4827	9.1	9.7	0.003	92.8	67.4	0.80	92
4832	7.6	9.1	1/ 0.024	92.1	67.6	0.47	93
4833	8.2	7.5	0.095	91.2	59.7	0.07	95
4834	8.4	8.0	0.053	92.7	68.8	0.51	96
4835	7.6	8.1	0.047	93.1	63.2	0.36	92
4839	8.2	8.3	0.000	97.2	62.9	0.24	70
4843	8.1	9.2	1/ 0.023	92.9	68.2	0.41	90
4844	8.1	9.5	1/ 0.047	90.3	64.5	0.83	90
4845	8.6	8.8	0.066	92.6	68.2	0.28	92
4847	---	8.4	0.049	91.2	66.9	0.77	95
4849	7.4	7.1	0.017	94.0	65.6	0.77	94
4850	8.4	9.3	0.034	91.9	65.8	0.89	91
4854	7.4	7.1	-----	93.7	67.0	0.69	33
4855	8.8	9.3	0.015	92.8	61.2	0.89	95
4859	7.7	7.9	0.022	91.8	65.8	0.71	95
4861	7.5	7.8	-----	94.0	69.0	1.21	92
4863	9.7	9.3	0.016	92.4	62.9	0.70	92
4866	8.7	8.6	0.044	94.0	66.0	0.60	91
4869	7.9	8.1	0.023	91.6	69.8	0.53	96
4873	8.4	9.2	0.048	92.1	67.4	0.63	98
4876	8.5	7.9	0.092	93.8	68.0	0.61	94
4880	8.0	8.6	0.065	90.2	67.3	0.38	92
4882	8.3	9.1	1/ 0.031	91.3	70.4	0.42	90

(continued on next page)

TABLE 3. THICK JUICE PROCESSING (continued)

Key No.	Thin Juice pH	Thick Juice pH	Standard Liquor or Blow-Up		Filtration Data		
			Lime Salts	Purity	Brix	Filter-aid used per ton beets	Temperature
			%	%	0°	Lb.	C°
4885	8.2	8.2	0.091	92.1	65.0	0.51	97
4886	8.4	8.1	-----	92.6	64.9	0.91	92
4891	8.4	9.3	0.028	93.6	65.9	0.58	93
4893	8.5	8.8	0.054	92.7	63.3	0.85	100
4894	8.0	9.0	0.042	91.9	67.2	0.45	95
(B). Steffen Operations (1948)							
4802A	8.9	9.1	0.066	92.6	74.4	0.41	93
4802B	9.0	8.7	1/ 0.072	94.3	72.6	0.48	93
4807.	8.1	8.8	1/ 0.040	92.2	68.9	0.51	93
4820	8.5	8.1	1/ 0.068	92.6	63.9	0.33	84
4824	8.5	8.7	1/ 0.032	92.5	68.1	0.77	93
4826.	8.0	8.4	0.069	91.4	65.8	0.84	91
4828	8.1	8.2	0.106	88.1	61.6	0.38	93
4829	8.4	9.1	1/ 0.092	91.9	62.0	0.49	96
4830	8.1	8.5	1/ 0.059	90.0	69.1	0.63	86
4831	8.2	7.9	0.046	93.2	67.4	0.78	--
4837	8.6	8.2	0.087	93.2	68.1	0.50	92
4840	7.2	7.0	1/ 0.054	92.7	64.8	0.80	84
4841	8.1	8.4	1/ 0.049	92.6	68.0	0.54	94
4842	7.9	8.3	0.048	92.5	66.6	0.76	99
4846	7.6	7.3	0.055	92.4	68.2	0.69	94
4853	7.7	7.4	-----	94.0	68.2	0.89	90
4856	8.5	8.7	1/ 0.052	90.5	67.1	0.73	93
4857A	8.0	7.2	1/ 0.071	92.7	63.4	0.53	95
4857B	8.0	7.1	1/ 0.081	92.3	59.9	0.46	86
4860	7.9	8.2	0.050	95.0	67.9	0.52	87
4862	8.6	8.6	0.025	93.6	63.3	0.69	93
4864A	8.7	8.0	0.089	93.8	70.8	0.63	99
4864B	8.7	7.6	1/ 0.088	95.0	71.0	0.68	99
4865	8.1	8.7	1/ 0.050	91.4	67.2	0.63	90
4871	8.7	8.5	1/ 0.188	93.6	66.9	0.51	94
4872	8.3	8.8	1/ 0.033	90.0	66.9	0.73	96
4875	8.6	8.9	0.038	92.2	63.4	0.59	90
4877	8.0	---	0.016	91.8	67.2	0.32	93
4878	8.9	8.7	0.063	91.9	70.5	0.69	87
4879	7.7	6.9	0.070	94.9	64.9	1.38	91
4883	9.1	8.5	-----	93.2	64.6	0.33	91
4884	8.8	8.5	0.025	92.6	66.0	0.47	101
4890	---	---	0.005	94.8	65.2	0.24	85
4895	7.7	7.6	0.080	92.3	62.8	0.38	96
Mean A	8.29	8.60	0.044	92.36	66.22	0.606	91.0
Mean B	8.30	8.23	0.063	92.52	66.83	0.615	92.3

1/ Values determined on thin or thick juice.

TABLE 4. WHITE SUGAR PROCESSING

(A) Non-Steffen Operations (1948)

Key No.	White Massecuite				White Sugar Wash Water			High Wash Purity
	pH	Purity %	Brix	Cu. ft. per 100 lbs. sugar	Temperature C°	Qts. per machine	Qts. per 100 lbs. sugar	
4801	8.4	93.3	90.8	3.16	85	20.0	6.2	91.3
4803	8.4	91.0	90.0	3.40	90	18.0	---	91.0
4804	8.5	93.1	91.9	2.49	92	12.5	3.5	91.1
4805	8.9	92.2	90.9	3.04	110	18.1	6.0	92.5
4806A	7.4	91.6	91.4	---	112	12.0	3.8	90.1
4806B	7.2	92.5	92.1	---	112	12.0	3.8	93.0
4808	8.9	92.6	91.5	2.63	112	13.0	4.3	92.9
4809	9.9	91.9	92.4	3.21	100	12.0	---	90.8
4810	9.3	91.6	91.0	3.08	92	16.0	6.2	90.7
4811	9.1	90.0	91.9	2.77	95	19.0	6.8	91.0
4813	7.8	94.1	91.6	3.20	98	15.0	3.0	93.1
4814	9.2	90.9	92.3	3.10	101	14.0	4.0	90.0
4815	7.8	92.8	91.9	2.70	110	18.0	4.7	93.7
4816	8.7	91.7	92.0	3.11	109	14.0	3.4	----
4817	7.5	92.6	91.7	3.30	92	16.0	4.6	93.2
4818	8.4	92.0	91.5	2.94	123	16.0	4.0	92.0
4821	7.9	92.1	91.6	3.00	93	16.0	4.6	----
4822	9.2	90.6	91.4	3.19	94	16.0	5.6	92.3
4827	9.8	92.8	90.9	2.64	100	15.0	5.0	89.6
4832	9.0	92.0	92.0	2.93	92	16.0	6.4	92.4
4833	7.2	87.7	91.8	4.29	96	20.0	6.7	86.2
4834	7.8	92.5	91.8	3.04	97	16.0	5.7	94.7
4835	8.2	93.3	91.5	2.86	97	13.0	4.1	92.8
4839	8.1	95.6	90.1	----	110	13.0	3.2	----
4843	9.1	92.6	90.2	3.11	90	17.0	5.3	91.2
4844	9.5	90.7	91.7	2.93	97	17.0	----	92.1
4845	8.6	92.7	92.4	2.70	85	12.0	4.0	92.3
4847	8.2	91.7	90.0	2.19	105	16.0	3.7	91.3
4849	7.0	94.1	91.0	2.80	93	16.0	5.3	93.0
4850	9.2	92.0	90.9	3.30	95	16.0	6.2	90.6
4854	7.1	93.7	90.8	7.39 (?)	37 (?)	9.7	2.4	95.0
4855	9.1	92.9	91.8	2.81	95	16.0	6.2	89.9
4859	7.8	91.7	91.1	3.03	95	17.0	5.9	93.6
4861	7.6	95.1	91.2	2.86	90	----	----	94.7
4863	9.4	92.1	92.7	----	98	12.0	3.3	89.9
4866	8.0	93.7	91.0	2.98	97	13.5	3.8	93.6
4869	8.2	91.9	91.8	2.99	92	16.0	5.1	91.1
4873	9.1	92.9	91.7	2.79	96	17.0	5.7	94.7
4876	7.8	93.9	92.0	2.98	111	16.0	5.3	95.2
4880	8.5	90.4	92.1	2.96	116	16.0	5.5	91.8
4882	9.1	91.3	91.2	2.80	91	17.0	6.8	89.3
4885	7.9	91.8	92.6	2.96	105	17.4	4.7	94.0
4886	7.9	92.8	91.5	2.58	---	18.0	---	96.8

(continued on next page)

TABLE 4. WHITE SUGAR PROCESSING (continued)

Key No.	White Massecuite				White Sugar Wash Water			High Wash Purity
	pH	Purity	Brix	Cu. ft. per 100 lbs. sugar	Temperature	Qts. per machine	Qts. per 100 lbs. sugar	
		%			C°			
4891	9.4	93.9	90.0	2.91	50	11.0	4.1	92.6
4893	8.7	93.6	91.0	2.86	110	13.5	---	93.0
4894	9.4	92.1	91.9	3.15	124	16.1	5.8	93.7
(B) Steffen Operations (1948)								
4802A	8.0	93.4	92.4	2.81	99	14.0	5.6	92.9
4802B	8.0	94.2	91.8	2.65	98	12.0	4.8	92.9
4807	8.8	92.2	90.3	3.02	96	14.0	5.0	90.4
4820	8.0	92.7	91.7	3.41	97	15.0	6.4	91.3
4824	8.8	92.6	92.4	2.95	93	18.0	6.0	90.8
4826	8.5	91.3	91.9	----	108	11.0	4.1	90.1
4828	8.4	87.8	93.0	----	91	16.0	----	85.4
4829	8.7	92.3	91.6	----	110	15.0	5.0	93.0
4830	8.7	90.5	90.7	3.55	88	16.0	----	91.3
4831	7.9	93.2	89.9	2.98	105	15.9	5.4	92.9
4837	8.7	93.3	90.6	3.23	110	16.0	4.0	92.2
4840	7.1	92.2	91.1	3.34	94	12.0	4.5	89.5
4841	8.5	92.4	91.2	2.99	99	18.0	6.8	90.7
4842	8.4	91.7	91.2	3.04	95	18.0	----	90.9
4846	7.9	92.4	90.9	2.82	98	16.0	---	92.8
4853	7.8	94.2	91.7	----	95	12.7	---	93.2
4856	8.7	90.5	92.1	3.40	94	14.0	5.8	91.3
4857A	7.2	93.1	90.5	3.42	100	17.0	6.5	----
4857B	7.2	92.2	90.7	3.58	100	18.0	7.2	----
4860	8.2	95.0	89.8	3.12	115	16.1	---	96.4
4862	8.1	92.6	91.8	3.17	110	14.0	4.8	90.5
4864A	7.6	93.9	90.9	----	94	16.0	6.4	93.3
4864B	7.4	95.2	90.6	----	95	16.0	6.5	93.7
4865	8.7	91.6	89.4	3.23	93	18.0	---	89.7
4871	8.1	93.6	90.4	3.23	95	15.3	5.5	----
4872	8.7	90.0	92.2	3.51	92	15.0	6.6	90.1
4875	8.7	91.9	91.8	2.89	94	16.0	5.0	90.4
4877	8.7	91.7	91.3	2.81	94	15.0	5.3	91.5
4878	8.2	92.0	92.6	2.85	93	16.0	5.0	91.5
4879	6.9	94.0	90.1	----	103	12.0	3.0	----
4883	8.2	93.2	91.4	2.90	--	22.0	5.8	----
4884	8.4	92.0	91.6	2.71	98	18.0	3.7	89.6
4890	9.8	94.8	89.6	3.28	120	10.0	----	94.0
4895	7.3	92.8	90.2	2.92	111	16.0	4.7	93.2
Mean A	8.41	92.29	91.50	2.97	97.6	15.43	4.82	92.09
Mean B	8.16	92.47	91.24	3.10	98.3	15.50	5.38	91.42

for Steffen operations. Approximately 40% of the non-Steffen and 30% of the Steffen factories used superheated water. In 1940 only 2% used this improved washing technique.

(5) Raw sugar processing (Table 5). The average data for high and low raw massecuites and sugars do not show any significant differences from recent years.

(6) Use of activated carbon (not tabulated). Somewhat fewer than half of the factories used small amounts of decolorizing vegetable carbons. The amounts used ranged from 0.002 to 0.39 pounds per 100 pounds of white sugar produced. Where used the average amount was 0.094 lb., but 39 factories did not use any.

(7) Data on sugar as sacked (not tabulated). The temperature of the white sugar as sacked ranged from 33° to 60°, and averaged close to 46°C. This average is about 1.5° higher than in the 1947 campaign. The moisture in the sugar ranged from 0.009 to 0.054%, and averaged 0.027% on non-Steffen sugars and 0.029% on Steffen sugars. These values are essentially the same as in the previous year.

(8) Processing changes in nonsugars (Table 6). The data in this table are largely calculated from the purity, polarization, and solids data already tabulated. The table includes similar data on molasses produced. Only non-Steffen data are presented. Columns 1 and 2 show the approximate amounts of nonsugars in diffusion juice as percentage on beets and on polarization (sucrose). The latter values are essentially another way of expressing purity. It is to be noted that juice nonsugars percent beets range from 1.76% to 3.31%. The juice nonsugars percent sucrose range from 10.4% to 21.2%. These values indicate the large differences in quality of diffusion juices and of beets at various locations.

Column 3 gives the calculated nonsugars in white massecuite as percentage on polarization or sucrose, and column 4 gives the difference between these values and that for the nonsugars percentage of sucrose in juice (column 2). The improvement in the ratio of nonsugars to sucrose shown by the white massecuites is the result of the elimination of nonsugars by the juice clarification and the dilution of the nonsugars by the added raw sugar melts and high wash. The amount of improvement of the nonsugar to sucrose ratio shown in column 4 is very widely variable being affected not only by the natural differences in case of nonsugar elimination by clarification but also by the quantity and purity of the raw sugars melted. On the average it is evident that the amount of nonsugars percent sucrose at the white massecuite stage is approximately reduced to nearly one-half by the factory processing. When beet purities are low it is natural that the proportion of nonsugars change from juice to massecuite is relatively high. In column 5 the change in nonsugars, % sucrose, from juice to massecuite, is expressed as percentage of the amount in the juice.

Column 6 gives the nonsugars of the molasses produced as percentage on beets and column 7 the difference between nonsugars in juice and in molasses on the beet basis. Column 8 gives the percentage of nonsugars eliminated;

TABLE 5. RAW SUGAR PROCESSING

(A) Non-Steffen Operations

Key No.	High Raw Massecuite			High Raw Sugar	Low Raw Massecuite			Low Raw Sugar
	Purity	Brix	Cu. Ft. per 100 White Sugar	Purity	Purity	Brix	Cu. Ft. per 100 White Sugar	Purity
4801	84.7	91.9	0.84	98.3	76.6	92.7	0.53	96.5
4803	82.2	92.5	1.64	97.9	73.3	98.6	0.66	92.1
4804	84.6	92.6	0.77	99.1	74.5	92.7	0.46	92.9
4805	84.7	92.5	—	98.1	74.6	94.4	0.98	90.6
4806A	86.6	92.8	—	98.1	76.0	93.5	—	93.5
4806B	86.8	93.4	—	98.6	75.8	94.1	—	92.4
4808	84.4	93.1	1.61	97.4	75.3	93.6	0.51	90.3
4809	85.5	92.8	1.19	96.6	76.0	93.6	0.54	90.8
4810	82.6	93.5	1.43	—	72.8	97.5	0.60	—
4811	83.1	95.7	1.62	97.6	72.3	98.9	0.85	84.7
4813	85.4	92.2	1.50	98.6	77.6	93.3	0.50	94.3
4814	81.8	94.5	1.40	97.2	71.6	94.6	0.60	97.2
4815	86.4	92.6	0.99	99.3	77.1	93.4	0.71	94.6
4816	84.2	92.9	1.59	96.4	72.9	93.7	0.72	88.5
4817	87.0	92.0	1.51	99.5	77.5	94.2	0.89	98.0
4818	86.0	92.2	1.19	97.4	76.5	93.6	0.56	95.0
4821	86.4	91.6	1.21	98.2	76.0	92.1	0.72	95.6
4922	82.7	94.5	1.49	96.3	72.7	97.5	0.72	91.3
4827	86.3	92.1	0.89	97.6	76.4	94.2	0.51	93.7
4832	85.0	94.2	1.18	98.7	72.8	98.0	0.58	87.6
4833	—	—	—	—	74.2	93.4	0.53	93.8
4834	87.9	92.8	2.56	98.0	77.6	94.8	1.04	93.3
4835	85.5	92.7	1.82	98.2	75.0	96.0	0.65	86.7
4839	86.0	91.2	0.58	96.2	70.6	92.0	0.15	91.2
4843	84.6	93.9	1.41	98.9	73.7	96.2	0.47	89.6
4844	82.1	93.4	1.31	96.8	73.0	97.4	0.79	90.4
4845	85.7	93.4	1.33	98.3	77.6	92.8	0.76	97.3
4847	84.1	91.4	0.80	98.1	73.8	91.7	0.60	97.6
4849	87.3	91.5	1.07	99.5	77.9	92.8	0.55	95.5
4850	82.3	93.4	1.60	97.6	72.2	99.0	0.56	89.2
4854	87.3	90.9	2.83	99.1	78.4	92.1	0.55	76.6
4855	84.5	92.4	—	94.3	76.6	93.1	—	92.1
4859	84.2	93.1	1.05	95.3	73.9	96.8	0.54	88.9
4861	88.3	90.7	1.16	97.2	78.5	92.2	0.54	91.4
4863	83.4	85.1	—	98.1	76.5	94.1	—	93.9
4866	84.4	91.7	1.27	96.6	76.8	94.1	0.52	95.2
4869	85.8	91.5	1.61	97.4	76.9	94.7	0.79	93.6
4873	84.1	96.0	1.59	98.8	74.7	98.7	0.64	90.9
4876	85.3	92.5	1.49	97.8	74.7	92.7	0.54	90.5
4880	83.3	94.1	1.73	96.4	73.2	95.2	0.72	91.0
4882	83.6	93.3	1.10	97.9	72.7	97.4	0.57	88.1
4885	86.2	93.5	1.83	98.2	77.1	94.7	0.89	95.9
4886	86.8	92.2	1.52	99.1	77.8	92.2	0.84	96.1
4891	87.2	91.7	0.82	95.5	76.9	93.8	0.49	93.8
4893	86.7	91.5	1.18	99.1	76.6	93.0	0.55	90.2
4894	85.2	86.5	1.06	97.9	76.2	93.4	0.56	93.6

(continued on next page)

TABLE 5. RAW SUGAR PROCESSING (Continued)

(B) Steffen Operations

Key No.	High Raw Massecuite			High Raw Sugar	Low Raw Massecuite			Low Raw Sugar
	Purity	Brix	Cu. Ft. per 100 White Sugar	Purity	Purity	Brix	Cu. Ft. per 100 White Sugar	Purity
4802A	87.1	93.7	2.49	99.2	76.7	94.9	0.96	93.6
4802B	88.3	93.8	2.81	97.2	77.1	94.9	0.99	93.1
4807	85.0	92.1	1.59	95.9	75.4	94.5	0.60	87.8
4820	87.5	91.0	1.37	96.8	78.4	92.8	0.69	95.0
4824	85.2	93.0	1.21	95.9	75.4	94.4	0.61	91.2
4826	83.5	93.5	1.97	97.3	74.9	95.2	0.74	91.0
4828	79.9	93.3	—	96.7	76.0	94.9	—	94.9
4829	85.4	92.4	1.70	96.7	75.4	93.2	0.71	91.3
4830	84.1	92.4	1.94	92.7	74.8	96.8	0.89	87.3
4831	87.0	90.8	1.43	99.7	78.5	91.7	0.79	95.3
4837	86.2	92.6	1.47	97.1	77.7	92.2	0.77	93.3
4840	86.2	91.5	1.06	97.0	78.3	90.7	0.62	90.8
4841	84.2	92.7	1.38	97.1	75.2	94.4	0.59	87.8
4842	84.4	91.4	1.70	—	76.4	93.2	0.59	—
4846	85.9	91.8	1.06	99.4	78.7	92.9	0.92	92.9
4853	88.6	91.9	1.21	99.0	81.2	94.3	0.62	90.6
4856	82.5	94.2	2.06	97.0	72.3	97.6	0.86	86.7
4857A	86.6	91.1	1.95	99.7	76.6	91.7	0.88	94.7
4857B	86.6	91.0	1.83	99.7	76.5	91.6	1.03	95.1
4860	89.8	89.8	1.45	99.5	81.0	90.7	0.74	93.5
4862	84.0	91.7	0.86	96.1	76.7	92.8	0.57	93.8
4864A	86.9	92.5	2.88	99.3	76.7	95.0	0.99	91.6
4864B	86.9	92.8	3.72	99.1	76.5	94.9	1.36	90.5
4865	84.3	90.8	1.74	96.0	74.2	94.3	0.70	87.9
4871	88.4	90.8	1.98	98.6	80.4	91.5	1.11	96.8
4872	82.5	92.9	1.68	92.9	74.0	96.6	0.84	86.1
4875	84.4	93.4	1.28	97.4	74.7	95.6	0.68	92.0
4877	84.9	92.5	1.37	96.8	75.7	93.5	0.71	92.3
4878	87.0	94.3	1.61	98.1	77.5	95.6	1.12	93.7
4879	86.9	89.7	0.96	98.2	78.6	90.5	0.36	92.7
4883	87.5	91.6	1.80	98.9	79.5	91.9	0.99	98.3
4884	86.3	90.7	1.50	96.2	77.2	92.9	0.63	93.6
4890	87.7	87.5	3.28	—	78.8	87.6	0.35	—
4895	85.6	90.7	1.37	98.5	76.3	91.9	0.66	92.4
Mean A	84.98	92.63	1.398	97.77	75.16	94.61	0.638	92.10
Mean B	85.75	92.12	1.711	97.46	76.82	93.68	0.795	92.10

TABLE 6. PROCESSING CHANGES IN NON-SUGARS
(Non-Steffen Operations)

Key No.	Nonsugars in Diffusion Juice		Nonsugars in White Massecuite			Nonsugars in Molasses				
	% on Beets (1)	% on Sucrose (2)	% on Sucrose (3)	Change Amt. (4)	Change % (5)	% on Beets (6)	Change Amt. (7)	Change % (8)	% on Sucrose (9)	Sucrose % on Nonsugars (10)
4866	1.96	10.40	6.72	3.68	35	1.37	0.55	29	69.9	1.43
4813	1.99	11.01	6.27	4.74	43	1.47	0.52	26	69.0	1.45
4849	1.86	11.08	6.27	4.81	43	1.20	0.66	35	61.5	1.62
4854	1.76	11.25	6.72	4.53	40	1.54	0.22	13	77.0	1.30
4891	1.93	11.36	6.50	4.86	43	1.15	0.78	40	58.1	1.72
4818	2.04	11.97	8.69	3.28	27	1.25	0.79	39	67.9	1.47
4894	2.12	12.33	8.58	3.75	30	1.48	0.64	30	63.0	1.59
4876	1.96	12.48	6.50	5.98	48	1.29	0.67	34	68.3	1.46
4843	2.07	12.74	7.99	4.75	37	1.04	1.03	50	63.0	1.58
4801	2.10	12.84	7.18	5.66	44	1.41	0.69	33	65.6	1.52
4839	2.03	12.89	4.60	8.29	64	0.48	1.55	76	73.8	1.35
4808	2.23	13.65	7.99	5.66	41	0.89	1.34	60	53.9	1.85
4832	2.12	14.31	8.69	5.62	39	1.26	0.86	41	70.4	1.42
4893	2.43	14.33	6.84	7.49	52	1.40	1.03	42	68.3	1.46
4810	2.23	14.40	9.17	5.23	36	1.27	0.96	43	67.5	1.48
4859	2.33	14.42	9.05	5.37	37	1.26	1.07	46	66.7	1.50
4804	2.66	14.49	7.41	7.08	49	1.47	1.19	45	71.0	1.41
4882	2.16	14.67	9.53	5.14	35	1.26	0.90	42	76.4	1.31
4827	2.40	14.81	7.76	7.05	48	1.19	1.21	50	57.2	1.75
4873	2.23	14.84	7.64	7.20	48	1.36	0.87	39	73.5	1.36
4815	2.48	14.92	7.76	7.16	48	1.62	0.86	35	66.9	1.49
4850	2.14	15.07	8.69	6.38	42	1.37	0.77	36	72.9	1.37
4821	2.57	15.20	8.58	6.62	44	1.71	0.86	33	67.6	1.48
4814	2.41	15.31	10.01	5.30	35	1.30	1.11	46	66.7	1.50
4809	2.48	15.33	8.81	6.52	42	1.97	0.51	21	93.4	1.07
4863	2.56	15.63	8.58	7.05	45	1.48	1.08	42	63.5	1.57
4803	2.20	15.88	9.89	5.99	38	1.37	0.83	38	69.2	1.44
4861	2.57	16.14	5.15	10.99	68	1.04	1.53	60	53.3	1.87
4855	2.73	16.14	7.64	8.50	53	1.50	1.23	45	63.5	1.57
4822	2.34	16.25	10.37	5.88	36	1.41	0.93	40	70.5	1.42
4811	2.31	16.52	11.11	5.41	33	1.50	0.81	35	67.0	1.49
4833	2.79	16.81	14.02	2.79	17	1.39	1.40	50	68.1	1.47
4816	2.70	16.84	9.05	7.79	46	1.49	1.21	45	67.1	1.49
4869	2.60	17.07	8.81	8.26	48	1.52	1.08	42	60.1	1.66
4886	2.99	17.10	7.76	9.34	55	1.99	1.00	33	65.0	1.54
4835	2.60	17.65	7.18	10.47	59	0.86	1.74	67	43.6	2.29
4805	2.53	17.78	8.46	9.32	52	1.15	1.38	54	64.6	1.55
4817	2.73	17.90	7.99	9.91	55	1.85	0.88	32	69.3	1.44
4844	2.43	17.96	10.25	7.71	43	1.65	0.78	32	75.0	1.33
4845	2.78	18.07	7.87	10.27	57	1.67	1.12	40	63.7	1.57
4847	2.96	18.34	9.05	9.28	51	1.42	1.54	52	69.3	1.44
4806B	2.94	18.91	8.11	10.80	57	1.74	1.20	41	68.0	1.47
4885	3.27	18.91	8.93	9.98	53	1.89	1.38	42	62.4	1.60
4806A	3.31	18.93	9.17	9.76	52	1.95	1.36	41	66.8	1.50
4880	3.10	20.30	10.62	9.68	48	1.44	1.66	54	68.9	1.45
4834	3.05	21.19	8.11	13.08	62	1.85	1.20	39	65.8	1.52
Mean	2.439	15.36	8.31	7.05	46	1.417	1.022	42	66.7	1.50

that is, the ratio of the values in column 7 to those in column 1. The average betterment of the nonsugar ratio to sucrose between juice and white massecuite was 46% (column 5) as compared with the 42% average elimination value (column 8). The difference represents the benefits produced by the added high purity liquors. In some instances, the improvement in the white massecuite is very slightly different from the elimination value while in other cases the reduction of nonsugars % sucrose shown by the massecuite was nearly double that of the average example given.

In the case of ion-exchange the elimination of nonsugars was a high 76% but due to making multiple white sugar boilings the average white massecuite quality indicates only a 64% improvement over juice. Columns (5) and (8) are not strictly comparable as the bases are different. However, considered together, they indicate whether a low degree of improvement from juice to massecuite is due to poor nonsugar eliminations or the effect of the quantity and purity of raw sugars.

It is to be noted that the nonsugar elimination calculated is often very high even with the usual processing. This is probably largely a matter of the nature of the nonsugars in the juice. Little is known of the composition of the diffusion juice nonsugars at different producing areas but it is possible that the oxalate phosphate and protein contents would be important factors in the degree of elimination obtained by the usual processing methods.

Column 9 expresses the nonsugars in molasses as percentage on sucrose. These values indicate the melassigenic action of the nonsugars present. It is more common to give the reciprocal ratio, namely, the units of sucrose per unit of nonsugar and this is given in column 10. For example, if the average nonsugar percentage sucrose, 66.8%, is so expressed, the value is 1.5 units of sucrose per unit of nonsugar. As given in the table, the lower the value in column 9, the greater the amount of sucrose retained in molasses per unit of nonsugar. Thus, the lowest value given was 43.6% which corresponds to 2.3 as the sucrose per unit of nonsugar. The highest value given, 93.4, calculates only 1.1 sucrose per unit of nonsugar. For the ion-exchange process the value was 1.35, which corresponds very closely to the value given in the last report. Thus, the nonsugars not eliminated have a quite variable melassigenic effect. This is far from being a new observation but data along this line had not been previously published for the domestic sugar beet industry.

The data in table 6, and the discussion of these data are based on only the 1948 campaign results. A further examination has been made of the accumulated data on sugar losses to molasses as reported for the past 10 years. The year-to-year sugar losses at individual factories varied roughly by 0.5% on beets. The 10-year averages for 35 nonSteffen factories ranged from 1.75 to 2.65%, and the general average is 2.13% -- the sugar lost to molasses ranged from 35 to 53 lb. per ton of beets. Each factory characteristically shows a high, moderate, or low molasses production, the contrasts between different years being within the fairly narrow range indicated. The range of sugar loss typical of an individual factory arises from the composition and quantity of nonsugars in the diffusion juice and the operating efficiency of the low raw sugar boiling and crystallization. The composition of the nonsugars affects the proportion eliminated during clarification and the melassigenic activity of the residual nonsugars.

While ion-exchange will rather completely remove ionic nonsugars, both mineral and organic, it leaves some organic nonsugars and colloids and produces enough inversion so that molasses is still formed, with the result that at least 10 lb. of sugar per ton of beets is lost. Ion-exchange should be of most benefit where the normal sucrose loss per unit of nonsugar is high. For some additional comments on the use of ion-exchange see the Proceedings of the American Society of Sugar Beet Technologists for the 1948 Meeting (pp. 705-708).

(9) Sugar beet storage. Cooperation in this field of work has been discontinued but studies are being continued by the Bureau of Plant Industry, Soils, and Agricultural Engineering at their Salt Lake City laboratories (Division of Sugar Plant Investigations).

B. Chemical and Physical Data on the Composite Sugars

(1) Specific conductivity and ash content (Table 7). As will be recalled from previous reports the specific conductivity on white sugars is determined on a concentration of 30 grams of sugar in 100 cc. volume. A Leeds and Northrup ash bridge is used which has a temperature compensator yielding direct specific conductivity readings for a temperature of 20°C. The choice of the 30-gram concentration was made on the basis of experiments in which this was found to be the point at which the maximum total conductivity was obtained, and where a deviation of a gram of sugar more or less had slight effect on the conductivity. During a period of 4 years, more than 300 sugars, representing the different factories and years, were analyzed for gravimetric carbonate and sulphated ash and for specific conductivity. In round numbers the c-ratio (ash / specific conductivity) was 0.000395 for carbonate ash and 0.000500 for the fully sulphated ash. However, the sugars of individual factories differ from this mean relationship (complete data for the different factories were given in the report No. XXIII for the 1943 campaign (AIC-62), pp. 35-38).

For the past campaign specific conductivity was below the previous year for nonSteffen sugars; but the seasonal comparison was reversed for the Steffen sugars. Exceptionally high conductivities were observed on three of the Steffen sugars. The use of complete demineralization by ion-exchange at one nonSteffen factory and partial demineralization at two others had some effect on the general averages.

The ash values shown are calculated on the basis of specific conductivity and mineral ion composition by the procedure outlined in the report just mentioned. This calculation in part compensates for the differing composition of the ash constituents. In spite of this the general trends of the ash values naturally remained the same as for specific conductivity.

Since this is the last report on sugar quality it seems desirable to give a summary of the data of past years. Table 8 gives the values for carbonate ash before 1940, and the carbonate and sulphated ashes and specific conductivity for the period since 1940. The figures for the 1948 campaign are included in the averages. The data are given for some factories not operating in 1948. A comparison of the 1948 values of table 7 indicates the deviation of the present sugars from the 9-year average. The general mean for sulphated ash for 1948 was 123 p.p.m. as compared with the 1940-1948 average of 132 p.p.m.

TABLE 7. MINERAL COMPONENTS OF SUGARS

(A) Non-Steffen Operations

Key No.	Specific Conductivity X 10^{-6}	Mineral Analyses in p.p.m.				Calculated Ash Content in p.p.m.		Calculated Salts in p.p.m.		
		SO_2	SO_3	Cl	CaO	Carbonate	Sulphated Mineral		Org.	Tot.
4801	19.7	2	6	1	7	79	101	20	111	131
4803	27.3	9	10	10	7	104	133	61	91	152
4804	20.3	5	5	3	3	80	103	28	99	127
4805	25.1	3	12	1	6	98	126	35	123	158
4806A	23.0	2	7	11	5	89	114	41	94	135
4806B	20.2	2	7	3	4	80	103	24	107	131
4808	33.7	2	7	9	3	133	171	38	178	216
4809	28.0	1	6	1	2	114	146	16	178	194
4810	19.0	4	8	6	1	73	94	36	76	112
4811	28.0	3	20	10	1	106	136	67	89	156
4813	20.4	1	8	0	9	81	104	19	116	135
4814	25.4	4	9	11	3	97	124	46	101	147
4815	21.1	13	10	5	5	79	101	60	49	109
4816	21.8	4	7	2	3	86	110	27	113	140
4817	14.2	4	3	7	3	54	69	27	53	80
4818	23.9	4	6	1	12	95	122	22	136	158
4821	17.9	10	7	4	3	67	86	45	51	96
4822	22.3	7	10	4	2	85	109	42	88	130
4827	24.7	1	6	2	2	100	128	19	149	168
4832	15.3	5	6	6	1	58	74	36	48	84
4833	22.6	7	6	1	6	90	115	29	116	145
4834	19.0	4	3	7	4	74	95	29	86	115
4835	21.1	6	15	3	3	80	103	51	69	120
4839	8.0	1	1	0	2	33	42	4	52	56
4843	24.3	3	14	2	3	94	121	38	113	151
4844A	19.1	1	8	6	2	75	96	30	87	117
4844B	18.3	3	10	7	2	69	89	40	63	103
4845	19.5	1	3	14	5	75	96	36	76	112
4847	22.3	0	5	0	10	94	120	11	151	162
4849	22.0	9	10	3	5	83	107	48	76	124
4850	18.9	3	9	2	2	73	94	30	87	117
4854	21.4	3	8	3	2	85	108	28	109	137
4855	27.8	1	13	0	8	110	141	27	156	183
4859	30.1	29	15	12	1	107	137	119	9	128
4861	34.2	23	25	35	3	149	191	165	0	165
4863	23.3	1	4	12	4	91	117	34	107	141
4866	23.4	2	7	0	14	92	118	19	136	155
4869	29.0	5	10	2	3	114	146	36	149	185
4873	24.3	4	10	13	14	92	118	54	81	135
4876	11.3	2	2	0	4	46	59	7	71	78
4880	29.3	5	7	19	9	111	143	63	99	162
4882	22.4	5	10	7	1	85	109	47	80	127
4885	16.8	4	6	7	3	65	83	35	62	97
4886	14.0	2	4	2	8	55	71	17	73	90
4891	26.4	3	9	0	4	104	134	25	150	175
4893	25.7	2	8	1	5	104	134	21	155	176
4894	22.4	6	5	1	5	89	114	27	118	143

(continued on next page)

TABLE 7: MINERAL COMPONENTS OF SUGARS (Continued)

(B) Steffen Operations

Key No.	Specific Conductivity X 10^{-6}	Mineral Analyses in p.p.m.				Calculated Ash Content in p.p.m.		Calculated Salts in p.p.m.		
		SO_2	SO_3	Cl	CaO	Carbonate	Sulphated	Mineral	Org.	Tot.
4802A	17.0	1	3	5	4	69	88	19	92	111
4802B	17.7	1	2	3	4	71	91	14	105	119
4807	22.8	.3	6	2	3	90	116	22	128	150
4820	23.0	3	10	2	4	92	118	32	117	149
4824	29.4	6	12	13	5	111	143	64	99	163
4826	29.0	.5	14	13	14	110	141	63	100	163
4828	61.9	.2	14	42	8	236	303	117	236	353
4829	28.1	.1	7	14	5	110	141	42	128	170
4830	36.5	.6	17	13	6	140	179	74	135	209
4831	25.0	.6	9	2	6	99	127	37	121	158
4837	25.1	1	.7	4	6	100	128	24	140	164
4840	49.7	27	20	27	2	182	233	156	83	239
4841	25.0	.4	.7	11	2	95	122	46	97	143
4842	25.3	4	.6	3	3	100	128	32	129	161
4846	16.0	.4	.7	2	3	62	80	27	70	97
4853	29.0	.11	.7	3	2	112	144	45	132	177
4856	29.0	2	19	13	3	111	142	68	94	162
4857A	17.4	.4	10	3	4	66	85	35	69	104
4857B	19.6	4	10	3	4	76	97	35	82	117
4860	23.7	7	24	7	5	87	111	78	40	118
4862	33.5	.6	13	7	24	132	168	53	153	206
4864A	17.3	1	5	4	5	69	89	19	94	113
4864B	13.0	1	5	1	4	52	67	14	72	86
4865	33.4	6	15	10	3	128	164	62	133	195
4871	19.6	2	.6	2	8	78	100	20	109	129
4872	29.7	6	16	14	3	112	144	72	91	163
4875	54.4	8	7	15	28	214	274	63	282	345
4877	38.2	.9	12	17	2	147	188	79	138	217
4878	22.0	2	5	12	4	85	109	38	91	129
4879	44.6	12	80	16	17	182	233	224	0	224
4883	13.8	2	6	1	6	54	69	20	66	86
4884	35.6	10	15	6	4	137	175	65	145	210
4890	29.8	2	6	6	3	119	153	28	168	196
4891C1	9.0	.1	4	1	16	36	46	10	48	58
4891C2	10.5	1	7	4	15	40	51	24	36	60
4895	23.2	.5	8	2	9	93	119	31	119	150
Average A	22.12	4.8	8.3	5.8	4.5	86.4	110.8	38.8	94.5	133.3
Average B	28.29	5.2	12.4	9.1	6.3	109.7	140.5	55.0	111.6	166.6

TABLE 8. SUMMARY ASH DATA 1932 TO DATE

Key No.	Carbonate Ash Before 1940			Carbonate Ash 1940 to Date		Sulphated Ash 1940 to Date		Specific Conductivity 1940 to Date	
	Number Years	Extremes p.p.m.	Mean p.p.m.	Extremes p.p.m.	Mean p.p.m.	Extremes p.p.m.	Mean p.p.m.	Extremes 10^{-6}	Mean 10^{-6}
1	8	48-286	110	61-90	77	78-109	96	15.5-23.0	19.2
2	10	45-130	84	47-87	68	65-99	87	13.4-20.8	17.0
3	6	78-165	100	69-107	92	90-135	115	17.8-28.2	24.5
4	8	115-178	142	80-253	151	103-324	193	20.3-63.8	38.4
5	6	88-180	127	61-141	109	81-177	135	19.5-35.5	27.4
6	4	120-169	141	55-122	89	71-147	112	14.5-31.8	22.6
7	4	130-238	191	69-120	95	80-154	120	19.4-30.0	23.6
8	9	105-235	160	70-149	104	92-191	131	17.7-37.6	25.9
9	6	95-122	110	99-203	131	133-261	166	25.3-49.8	31.5
10	-	---	---	63-87	76	73-111	98	18.1-22.5	19.7
11	-	---	---	72-152	104	90-175	131	20.3-33.9	26.7
12	5	140-200	171	107-241	169	128-309	210	29.7-65.4	43.6
13	7	85-140	102	81-173	118	104-219	153	20.4-43.0	28.8
14	8	126-574	239	80-124	102	101-159	130	20.0-31.5	26.4
15	12	70-190	121	71-105	82	86-135	105	17.9-27.2	21.3
16	4	90-230	131	84-123	100	106-150	126	18.3-29.5	25.2
17	5	64-70	67	49-78	61	70-107	80	13.0-21.5	15.3
18	3	105-190	138	80-124	97	102-160	126	19.8-29.0	24.3
19	7	107-306	145	114-197	144	147-252	193	29.3-42.0	33.1
20	9	105-810	281	72-148	100	92-190	128	18.6-38.2	26.4
21	9	58-268	141	61-102	79	77-131	104	16.0-26.2	20.5
22	9	89-290	158	80-118	97	96-140	121	20.6-29.0	25.4
23	7	63-180	101	71-137	92	90-171	118	18.0-30.4	23.0
24	9	95-920	240	102-136	116	123-167	147	24.9-34.5	29.6
25	3	62-85	71	76-124	94	94-151	118	17.7-30.3	23.7
26	-	---	---	70-121	102	84-155	132	17.4-31.9	26.7
27	6	75-110	98	85-186	126	107-247	160	22.9-45.0	29.9
28	7	170-418	266	69-236	159	87-303	203	18.2-61.9	40.8
29	7	104-378	212	82-148	104	105-190	134	21.3-38.9	26.4
30	10	140-950	301	101-152	135	127-186	171	29.0-38.2	34.9
31	10	110-1930	397	93-136	108	119-164	136	24.1-30.8	26.7
32	10	85-240	137	58-100	82	74-128	102	15.3-25.8	20.8
33	8	113-240	149	60-124	91	77-148	115	15.7-26.2	22.0
34	4	58-91	71	62-105	77	80-134	97	14.2-26.8	19.4
35	3	87-140	106	65-124	87	94-144	111	16.1-30.5	23.2
37	10	87-340	171	89-197	130	112-253	166	23.2-49.5	32.7
1/39	7	125-395	225	33-204	110	42-215	138	8.0-43.0	26.9
40	8	120-291	168	106-182	136	136-233	177	29.5-49.7	35.9
41	--	---	---	89-116	102	112-149	131	22.9-30.0	26.2
42	--	---	---	80-118	99	108-150	128	22.2-29.8	25.0
43	9	95-540	195	62-123	94	80-158	120	18.1-31.5	24.7
44	--	---	---	61-104	80	76-134	99	16.1-27.5	20.6
45	6	52-75	64	58-104	73	75-133	97	15.0-27.2	19.4
46	10	55-196	105	62-99	80	80-127	103	16.0-25.2	19.8
47	6	100-203	155	68-194	117	86-232	146	16.8-51.0	28.8
49	10	110-190	138	83-125	104	107-167	131	22.0-32.3	26.4
50	--	---	---	59-81	71	83-104	91	14.6-20.8	18.4

1/ Excluding ion exchange processed sugar averaged 133 carb. ash 167 Sulp. ash and 32.8 specific conductivity

TABLE 8. SUMMARY ASH DATA 1932 TO DATE (continued)

Key No.	Carbonate Ash Before 1940			Carbonate Ash 1940 to Date		Sulphated Ash 1940 to Date		Specific Conductivity 1940 to Date	
	Number Years	Extremes p.p.m.	Mean p.p.m.	Extremes p.p.m.	Mean p.p.m.	Extremes p.p.m.	Mean p.p.m.	Extremes 10^{-6}	Mean 10^{-6}
51	4	80-120	108	47-131	92	60-164	119	11.8-32.7	22.9
52	9	75-135	101	91-174	133	117-223	170	21.9-44.8	32.2
53	2	111-115	113	63-112	85	82-144	105	15.8-29.0	21.2
54	--	---	---	85-112	99	104-144	124	21.4-30.0	25.1
55	7	79-108	96	68-135	97	87-162	123	17.1-30.0	24.1
56	10	95-410	152	72-111	91	82-142	112	18.8-29.0	23.4
57	10	74-240	119	66-94	83	85-122	105	17.4-24.3	20.9
59	9	100-350	169	89-138	121	122-178	156	25.3-38.1	32.5
60	9	160-610	266	87-179	121	111-231	152	23.7-46.4	31.5
61	4	125-200	154	79-180	119	107-231	151	21.4-36.7	29.9
62	6	78-156	114	86-160	114	110-188	144	22.0-35.5	28.5
63	8	45-138	105	87-127	111	112-151	140	22.5-31.8	28.0
64	9	50-139	86	25-76	58	32-97	75	6.1-18.8	14.3
65	10	118-980	294	84-130	115	113-164	144	24.1-33.4	28.5
66	8	40-214	94	65-102	85	82-149	109	15.7-25.2	19.9
68	8	100-318	198	132-296	190	180-377	246	32.9-74.5	48.7
69	3	85-214	139	84-137	110	108-175	141	20.0-35.1	28.5
71	6	68-129	103	63-78	71	79-100	90	12.8-19.6	17.1
72	9	100-580	198	96-154	121	123-188	153	26.0-34.1	30.8
73	7	107-480	196	92-121	106	118-156	136	24.2-32.9	27.8
75	10	120-470	257	116-214	156	130-274	195	29.3-54.4	39.9
76	3	45-60	53	37-60	52	50-70	64	11.1-16.7	13.3
77	10	105-390	201	91-180	143	109-222	175	24.3-45.0	35.7
78	10	85-280	135	78-116	92	95-148	119	21.7-26.3	24.1
79	6	80-160	122	100-182	124	126-233	156	24.5-44.6	31.0
80	8	113-340	188	82-162	108	107-210	138	19.8-42.0	27.9
82	--	---	---	69-109	90	80-140	112	19.2-28.2	23.1
83	3	55-80	68	54-74	65	69-98	85	13.8-18.1	16.4
84	3	142-224	185	81-137	116	102-175	144	21.1-35.6	29.9
90	8	65-270	132	66-139	112	95-178	142	19.1-33.6	28.1
91	--	---	---	104-161	136	134-216	174	26.4-41.1	33.6
93	--	---	---	104-108	106	134-138	136	25.7-27.2	26.5
94	--	---	---	80-116	98	114-148	126	21.2-29.7	24.8
95	--	---	---	93-172	128	118-221	162	23.2-42.5	31.0
96	--	---	---	147-268	222	186-323	263	35.9-61.0	48.1
Avg., 77 factories			155		104		132		26.28

The general relation of white pan purities and the ash content and quality of sugars has been pointed out in other reports. In individual instances the correlation is not always good but the over-all results show a definite relationship. As a review of past data on an annual basis the data of 45 factories, on which the records are essentially complete from 1932 to date, have been averaged and are presented in table 8. Because the values are from identical factories the annual comparisons are more accurate than the usual annual figures which are based on all operating factories including many on which the earlier data are not available.

In table 9 column 1 gives the polarization of the beets; column 2 the diffusion juice purities; and column 3 the diffusion juice nonsugars as percent on beet polarization. In column 4 are the mean annual white pan purities and in column 5 the calculated nonsugars percentage of sucrose for those white massecuites. The carbonate and sulphated ashes on the white sugars are shown in columns 6 and 7 expressed in p.p.m.

TABLE 9: ANNUAL MEANS FOR FORTY-FIVE FACTORIES 1932-1948 INCL.

	Beet	Diffusion Juice		White Massecuite		Ash on Sugars	
Year	Polarization	Purity	Nonsugars % Sucrose	Purity	Nonsugars % Sucrose	Carbonate p.p.m.	Sulphated p.p.m.
1932	16.30	85.61	16.8	87.54	14.2	238	---
1933	16.62	86.01	16.3	88.44	13.1	188	---
1934	16.64	86.22	16.0	89.83	11.3	156	---
1935	16.09	85.88	16.5	90.50	10.5	142	---
1936	15.91	85.93	16.4	90.84	10.1	138	---
1937	16.02	86.00	16.3	91.31	9.5	124	---
1938	15.91	86.31	15.8	91.62	9.2	115	---
1939	16.28	86.37	15.8	91.61	9.2	117	---
1940	15.80	86.64	15.4	92.04	8.7	103	131
1941	15.62	86.61	15.4	92.25	8.4	98	127
1942	15.45	86.28	15.9	92.10	8.6	115	139
1943	16.31	86.79	15.2	92.16	8.5	113	139
1944	16.84	87.20	14.7	92.12	8.6	104	130
1945	16.08	86.66	15.4	91.80	8.9	117	150
1946	15.69	86.42	15.7	91.93	8.8	114	146
1947	15.66	86.45	15.6	92.09	8.6	105	134
1948	15.67	86.70	15.3	92.30	8.3	106	135

It is to be noted that the nonsugars of diffusion juice had a relatively higher value during the period 1932-1937 inclusive than any time since. Whether this change was the result of changing beet varieties or poorer battery elimination cannot be stated. The trend to a 3-boiling system and abandonment of the topping off of white strikes with lower purity sirups is well shown by the rising white pan purities which became more or less stabilized again about 1940. The effects of the greater ratio of nonsugars to sucrose in the white massecuites on the ash content of the sugars is very evident. The minimum ash of sugar came in 1941 but the equally high white pan purity of 1948 did not give quite as good a result in this respect largely due to two or three sugars which were especially high in ash.

The ash content of sugars is of primary interest as a measure of refining efficiency. It has never been shown that ash in the range contained in the present day sugars has any bearing on the usability of the sugar for any purpose. The same can be said of individual constituents such as sulphates, chlorides, and lime. However, in the case of sulphites (SO_2) it has been observed that high quantities do affect the color of certain food products in very special instances. The appearance of the sugar, the color and turbidity in solution, and again only in special cases, the foaming characteristics when boiled, are the most important quality criteria.

(2) Ash constituents. Table 7 includes the analyses for the constituents sulphates (SO_3), sulphites (SO_2), chlorides (Cl), and lime (CaO). There is further included the approximate organic and mineral salt totals.

As a final record table 10 summarizes the sulphite and sulphate data up to now. There was a strong contrast between the period before 1940 and the later period. In the case of sulphites this difference amounts to 55%, that is, the average amount for the 1940-1948 period was 55% below the earlier average. For the sulphates the decrease was by 35%. The sulphite content for 1948 was well below the 1940-48 average. The amounts of the different ash constituents for individual factories seems to be greatly influenced by the salt characteristics of the producing area. The sugars in a particular area are all low in chlorides and in another location are all relatively high. This regional effect on the composition of the ash constituents has been dealt with in the publication entitled "Some Regional Effects of Beet Sugar Quality," Proceedings of the American Society of Sugar Beet Technologists for 1942. See also pp. 35-39 in the Beet Sugar Report for the 1945 Campaign.

Table 11 gives the chloride and lime values for the periods before and after 1940. The general averages indicate that the 1940-1948 sugars are about 30% lower in chlorides and 45% lower in lime than the sugars of the earlier period. The greater proportional change in the case of sulphites and lime is due to these constituents being within the control of factory operations.

The annual fluctuation in mineral ash constituents is presented in table 12. As in table 9, the data used was for the same 45 factories selected because of the more complete data.

The uniformity of the sugars of the past 10 years is very evident. If the total mineral salts be compared with the carbonate ashes of table 9 it will be found that the ash derived from metallo-organic salts is relatively constant throughout and it is essentially the mineral acid salts which decreased through the years 1932-1939 and produced the progressively lower ash contents.

TABLE 10. SUMMARY SULPHITE AND SULPHATE DATA 1932 TO 1948

Key No.	Sulphites (SO_2) Before 1940 Extremes p.p.m.	Sulphites (SO_2) Before 1940 Mean p.p.m.	Sulphites (SO_2) 1940-1948 incl. Extremes p.p.m.	Sulphites (SO_2) 1940-1948 incl. Mean p.p.m.	Sulphates (SO_3) Before 1940 Extremes p.p.m.	Sulphates (SO_3) Before 1940 Mean p.p.m.	Sulphates (SO_3) 1940 - 1948 Extremes p.p.m.	Sulphates (SO_3) 1940 - 1948 Mean p.p.m.
1	2-26	8.6	2-6	3.0	0-10	4.2	1-13	5.4
2	1-15	6.4	1-3	1.7	0-11	2.7	1-8	3.9
3	9-40	18.3	5-12	8.4	2-22	10.5	4-21	11.3
4	6-17	10.3	3-10	5.7	0-15	5.0	3-27	11.8
5	5-32	18.2	2-8	4.1	3-22	10.2	10-22	15.7
6	7-11	9.0	2-5	3.3	9-14	12.0	2-12	6.8
7	18-59	33.2	3-8	5.6	0-13	7.1	2-16	6.6
8	3-52	25.0	2-7	3.9	3-20	11.0	4-9	6.0
9	2-5	3.7	0-9	3.6	0-11	4.7	4-21	10.0
10	---	---	4-10	6.0	---	---	5-24	8.8
11	---	---	3-9	5.6	---	---	7-30	17.9
12	23-48	32.2	4-37	23.8	2-26	15.4	12-28	19.4
13	4-7	5.1	1-10	4.4	0-12	5.0	3-19	10.0
14	4-69	23.6	1-4	2.6	0-127	29.1	2-17	7.2
15	5-22	13.6	8-17	11.3	0-18	6.1	3-10	7.2
16	5-48	16.5	2-6	4.0	12-34	18.5	4-29	11.3
17	10-16	13.8	3-7	4.9	5-12	7.6	1-17	5.2
18	3-21	10.7	2-10	4.5	2-19	10.0	1-17	8.3
19	1-27	6.9	2-5	3.0	3-45	11.1	6-16	12.8
20	14-52	24.3	4-14	7.6	3-307	87.7	3-18	10.8
21	9-29	17.8	7-14	10.7	0-15	5.7	5-17	8.7
22	17-58	39.1	4-12	7.6	0-33	14.4	7-27	14.9
23	4-16	9.3	1-5	3.3	0-17	6.3	5-18	9.7
24	15-34	22.1	6-14	9.8	1-271	36.6	7-23	12.0
25	12-19	16.7	6-12	9.1	3-11	7.7	7-19	11.8
26	---	---	3-8	4.3	---	---	7-24	14.9
27	2-8	4.7	1-5	3.0	0-20	7.3	1-26	10.7
28	2-32	8.4	2-7	3.8	3-119	45.4	8-23	12.8
29	2-30	12.0	1-5	3.2	1-67	18.9	4-18	8.9
30	15-36	21.4	5-12	7.7	1-357	61.5	12-28	16.1
31	6-24	11.5	6-12	8.1	8-873	119.2	7-17	10.9
32	13-54	31.3	4-15	8.3	0-19	11.2	6-19	10.9
33	13-34	21.9	5-19	9.7	0-79	13.3	4-24	12.9
34	3-7	4.3	1-4	2.5	1-5	2.2	3-21	8.5
35	5-22	11.3	2-11	6.7	5-12	8.3	9-20	13.2
37	9-59	23.4	1-9	5.3	0-21	10.1	7-19	12.4
*39	4-50	16.1	0-14	5.2	12-111	32.4	1-20	12.4
40	7-34	17.2	9-35	21.2	1-16	6.7	3-27	14.3
41	---	---	4-8	5.7	---	---	7-17	10.3
42	---	---	4-9	6.3	---	---	2-23	9.8
43	11-36	21.9	3-13	6.0	3-223	54.7	5-21	12.3
44	---	---	1-13	4.8	---	---	5-21	10.8
45	3-11	5.0	1-3	2.3	0-5	1.5	3-11	5.8

* Before ion exchange #39 had SO_2 6.5, SO_3 16.0 p.p.m.

TABLE 10. SUMMARY SULPHITE AND SULPHATE DATA 1932 TO 1948 (Continued)

Key No.	Sulphites (SO_2) Before 1940 Extremes p.p.m.	Sulphites (SO_2) Before 1940 Mean p.p.m.	Sulphites (SO_2) 1940 - 1948 incl. Extremes p.p.m.	Sulphites (SO_2) 1940 - 1948 incl. Mean p.p.m.	Sulphates (SO_3) Before 1940 Extremes p.p.m.	Sulphates (SO_3) Before 1940 Mean p.p.m.	Sulphates (SO_3) 1940 - 1948 Extremes p.p.m.	Sulphates (SO_3) 1940 - 1948 Mean p.p.m.
46	1-12	3.6	3-9	5.2	0-9	3.0	5-21	9.1
47	4-19	10.5	0-4	1.7	3-14	9.5	0-20	7.9
49	29-62	43.4	9-28	21.3	0-22	6.2	9-25	14.0
50	---	---	2-12	5.3	---	---	3-16	9.1
51	8-20	13.3	2-12	7.0	8-17	11.5	1-20	10.7
52	5-20	12.3	4-28	11.8	0-12	4.8	4-26	16.6
53	12-15	13.5	4-15	8.8	1-7	4.0	3-16	8.3
54	---	---	3-19	14.7	---	---	6-15	10.1
55	1-7	4.0	2-8	4.5	0-43	12.1	5-20	10.8
56	8-29	17.8	2-9	6.2	0-146	20.9	5-21	12.1
57	5-22	12.4	4-7	5.0	0-10	3.8	5-20	11.2
59	10-50	27.6	19-39	29.0	0-22	11.4	15-22	16.7
60	22-46	32.2	7-20	11.0	13-160	38.6	10-37	22.6
61	19-36	29.7	15-26	21.6	7-17	12.7	6-54	21.6
62	2-12	4.8	3-8	4.6	0-14	5.8	4-20	11.3
63	3-16	7.8	1-11	3.8	0-17	4.3	3-22	7.0
64	1-4	2.3	0-6	2.4	0-11	4.1	2-21	6.3
65	10-46	20.9	5-9	6.1	7-309	46.5	7-19	11.7
66	2-19	8.6	1-6	3.5	0-12	3.5	2-10	6.0
68	12-76	29.8	4-14	9.4	0-26	14.5	14-30	19.4
69	18-53	30.0	5-16	9.3	2-13	8.0	5-23	13.1
71	1-10	6.2	1-2	1.6	2-20	8.5	5-16	7.0
72	9-20	15.8	5-14	8.7	3-235	42.2	3-20	13.3
73	7-13	9.4	2-12	6.3	4-231	45.1	1-29	11.1
75	7-40	18.1	2-9	5.4	2-191	69.8	7-43	19.0
76	2-10	6.0	1-5	3.1	5-14	8.3	2-16	5.3
77	8-24	16.4	3-11	5.4	0-34	15.4	8-42	16.0
78	2-10	6.0	2-4	2.8	0-45	12.9	3-17	7.8
79	6-22	13.2	4-17	10.8	3-19	11.3	8-80	25.5
80	2-54	23.0	1-8	4.4	12-20	15.2	6-16	9.3
82	---	---	5-14	7.8	---	---	4-18	9.6
83	1-4	3.0	1-4	2.5	0-6	3.0	3-10	5.7
84	13-27	18.0	6-14	9.8	11-15	13.3	6-16	12.1
90	0-3	1.0	0-2	1.0	0-7	2.5	2-27	10.0
91	---	---	2-14	5.3	---	---	8-14	10.0
93	---	---	2-5	3.5	---	---	6-8	7.0
94	---	---	3-6	4.6	---	---	3-12	7.5
95	---	---	5-7	6.1	---	---	6-13	9.0
96	---	---	4-11	8.0	---	---	11-18	14.3
		15.5	Average	6.9		17.5		11.3

TABLE 11: SUMMARY OF CHLORIDE AND LIME DATA 1932 TO 1948

	Chloride (Cl)				Lime (CaO)			
	Before 1940		1940-1948 incl.		Before 1940		1940-1948 incl.	
Key	Ex.	Avg.	Ex.	Avg.	Ex.	Avg.	Ex.	Avg.
1	1- 6	3.2	0- 5	2.1	5-23	10.8	3- 7	5.0
2	1-25	9.0	1- 6	3.8	4-14	7.1	3-10	6.1
3	2- 5	4.2	3-13	7.2	3-13	6.7	1- 7	3.4
4	1-17	7.1	3-27	11.8	1-17	7.1	2- 8	4.1
5	1-11	3.5	1- 5	2.4	2- 8	5.2	1- 6	4.1
6	4-35	18.5	1-12	6.5	9-19	12.0	3- 8	4.9
7	1-10	4.2	1- 4	3.2	4- 5	4.5	1- 5	2.2
8	2-28	9.0	1- 9	5.1	6-18	10.0	1- 7	4.4
9	1- 9	3.3	0- 3	1.1	9-15	11.5	2- 9	6.0
10	---	---	2-17	7.1	---	---	1- 6	2.6
11	---	---	2-16	10.2	---	---	1- 6	3.4
12	3-31	21.0	6-36	17.8	4- 8	5.8	2- 8	4.6
13	0- 9	2.9	0- 4	1.4	5-11	8.2	3-11	5.8
14	21-58	37.8	4-16	11.2	5-10	6.1	1- 8	3.8
15	0- 9	3.1	1- 6	4.1	4-11	7.4	3-12	8.6
16	2- 3	2.6	2- 6	3.8	5- 6	5.3	2- 8	4.9
17	7-13	10.4	5- 7	6.0	5- 8	7.0	1- 6	3.9
18	2-11	6.3	1- 4	2.0	7-23	16.3	3-12	7.0
19	0- 6	2.8	0- 3	1.0	6-20	13.0	8-16	10.7
20	2-33	9.2	1-15	6.9	5-117	35.3	2-11	5.5
21	1- 8	4.2	1- 7	4.0	4-30	11.8	1-12	5.0
22	3-40	12.3	2-11	6.4	3- 8	5.6	1- 8	4.0
23	2- 6	3.2	0- 4	1.3	4- 8	4.8	1- 7	4.3
24	0-15	6.6	5-13	10.6	2-13	7.1	1- 6	5.5
25	6-14	11.0	7-22	12.1	5-11	7.3	1-12	5.3
26	---	---	4-13	8.3	---	---	0-14	5.8
27	0- 3	1.6	0- 8	2.2	3-10	6.3	1- 9	4.6
28	13-35	22.7	11-42	20.9	8-64	18.3	4- 8	6.9
29	13-32	23.8	5-20	11.4	8-56	19.3	4- 8	5.6
30	2-18	6.0	6-18	10.2	6-16	8.6	1-11	5.6
31	2-18	9.7	1-11	5.3	4-17	9.0	3-10	5.6
32	8-35	18.3	4- 9	7.1	3-13	5.4	1- 5	2.4
33	2-16	5.8	1- 5	3.1	3-22	13.8	5-10	8.2
34	5-11	7.3	2-12	7.3	4-11	7.3	3-15	8.3
35	7-17	13.0	3- 7	5.1	3-13	8.0	1- 6	3.7
37	1- 7	4.2	0-10	4.9	6-15	10.2	3- 8	6.5
*39	15-43	24.9	0-22	8.6	8-22	12.1	1-20	8.3
40	1-26	9.3	3-27	14.3	4-10	7.4	2-12	5.0
41	---	---	2-11	5.1	---	---	1- 8	3.8
42	---	---	1- 8	3.6	---	---	1- 6	3.1
43	0-11	4.8	2-16	5.1	2-47	10.5	1- 7	3.4
44	---	---	5-11	7.9	---	---	2-11	3.5
45	4-11	8.7	3-16	9.7	5-11	7.7	5-12	7.5
46	0- 4	1.9	0- 3	1.7	4-32	11.0	1- 7	3.9
47	2-35	9.1	0- 2	1.0	7-19	12.7	1-11	5.2
49	1-12	4.9	2- 9	4.1	2- 6	4.1	0- 5	2.2

* Before ion exchange Cl was 11.5, CaO 9.7

TABLE 11: SUMMARY OF CHLORIDE AND LIME DATA 1932 TO 1948 (Continued)

	Chloride (Cl)				Lime (CaO)			
	Before 1940		1940-1948 incl.		Before 1940		1940-1948 incl.	
Key	Ex.	Avg.	Ex.	Avg.	Ex.	Avg.	Ex.	Avg.
50	---	---	2- 7	4.3	---	---	0- 6	2.9
51	3-10	5.2	2- 5	3.2	7-16	10.0	3-11	6.8
52	1- 7	3.8	2- 9	3.8	3-15	8.9	4-24	11.2
53	2- 6	4.0	1-13	3.8	6- 8	7.0	2-10	4.2
54	1-37	14.8	3-19	7.8	5-103	19.2	1- 6	3.2
55	0- 8	3.2	0- 3	1.3	7-16	12.2	4-10	6.9
56	2-13	8.3	5-13	8.9	2-12	5.2	0- 8	3.5
57	1-33	8.4	2- 9	4.0	2-11	7.6	3- 9	5.1
59	0-36	8.7	3-16	8.2	3-10	6.3	1- 5	3.2
60	12-44	31.1	3-29	12.2	3-46	10.9	2-12	6.4
61	24-25	24.7	9-35	17.9	4-13	8.0	1- 8	3.5
62	0-15	5.7	2-15	6.9	4-13	9.0	3-24	8.2
63	1- 8	3.8	1-15	8.1	4-18	8.9	1- 6	3.3
64	2-14	9.7	0- 5	3.0	2-16	8.0	1- 8	4.6
65	1-34	13.4	2-10	6.6	3-11	6.1	1- 5	3.0
66	0-18	3.8	0- 3	1.8	4- 9	6.5	2-14	5.8
68	0-12	5.1	2- 7	3.6	8-48	14.5	3-10	6.0
69	6- 8	7.0	2- 8	4.2	4- 8	6.7	1- 6	3.2
71	3-13	8.7	0- 3	1.8	6-14	9.0	1-10	7.3
72	0-28	15.3	7-18	13.4	3-15	7.7	1- 8	4.0
73	6-18	12.7	5-21	12.0	2-19	9.2	6-17	10.0
75	4-28	12.9	9-20	14.1	6-38	16.4	5-28	12.0
76	2- 2	2.0	1- 5	2.4	5- 8	5.3	1- 6	3.4
77	0-23	8.9	5-18	12.8	4-100	19.4	2- 4	3.5
78	2-32	15.1	11-21	14.7	4-19	10.2	2-10	5.1
79	2-10	5.8	1-16	11.2	7- 9	8.2	5-17	10.2
80	18-56	46.8	5-25	14.2	3- 8	7.0	3-11	6.8
82	---	---	4-12	7.7	---	---	1- 6	2.9
83	3- 9	5.7	1- 8	3.9	7-11	9.3	2- 7	5.3
84	12-20	16.3	3-16	8.2	7-14	10.0	3- 9	4.9
90	0- 2	0.4	0- 6	2.2	2- 6	3.8	2- 7	3.6
91	---	---	0-11	4.8	---	---	4- 8	6.2
93	---	---	1- 2	1.5	---	---	5- 8	6.5
94	---	---	1- 5	2.9	---	---	5-14	7.5
95	---	---	1- 8	3.8	---	---	8-22	12.5
96	---	---	0- 6	3.7	---	---	6- 8	7.3
Average		9.7		6.8		9.5		5.2

TABLE 12: ANNUAL MEANS FOR FORTY-FIVE FACTORIES

Year	Sulphites SO_2 p.p.m.	Sulphates SO_3 p.p.m.	Chlorides Cl p.p.m.	Lime CaO p.p.m.	* Total Mineral Salts p.p.m.
1932	24	25	12	14	130
1933	25	19	15	11	126
1934	18	20	9	9	100
1935	14	18	8	8	85
1936	13	15	7	7	74
1937	13	15	12	8	84
1938	12	8	10	8	63
1939	10	10	8	10	59
1940	8	18	7	4	69
1941	9	8	6	5	49
1942	6	9	7	5	46
1943	8	12	8	6	58
1944	9	14	7	5	63
1945	6	13	8	6	56
1946	8	10	9	6	56
1947	7	9	7	6	48
1948	6	11	8	6	52

*Mineral salts calculated from the acid ions with a potassium sodium base in the ratio of 2 to 1.

(3) Salt composition (Tables 7 and 13). The distribution between mineral and organic salts and the approximate total salt content have been reported since 1940. These studies have been based on the true ash alkalinities corrected for the intial concentrations of sulphites, sulphates and chlorides. The values for 1948 are given in Table 7 and the average figures for the period 1940 to 1948 inclusive in table 13. The arrangement in table 13 is according to the organic salt as percentage of total salts. To a very considerable degree sugars from particular localities are characteristically low or high in this ratio. That is, some areas yield sugars high in organic salts and others are high in mineral salts. These differences affect the c-ratio for conductivity ash calculations so that c-ratio factors are included with the sulphated ash averages.

Only a few c-ratios do not quite fit the general pattern of dependence on the proportion of organo-metallic salts; for the most part, the agreement with this correlation is predominant. Since the values in table 13 are 9-year averages they should indicate rather reliably the general characteristics of the salt nonsugars of the product of each factory; and the corresponding c-ratios should be reliable especially for use by any who wish to adopt the 30-gram concentration of sugar for the specific conductivity measurement. In a few instances, the values are for only the one or two campaigns during which these particular factories have operated in the 9-year period.

TABLE 13: APPROXIMATED SALTS, 1940 - 1948 AVERAGES

Key No.	Sulphated Ash p.p.m.	Total Salts p.p.m.	Mineral Salts p.p.m.	Metallo-Organic Salts p.p.m.	Metallo-Organic Salts % Total.	Conductivity-Ash c-ratio
61	141	129	129	0	0.0	0.000472
40	170	135	106	29	21.5	474
59	150	149	117	32	27.4	462
49	124	129	86	43	33.3	470
79	147	156	99	57	36.5	473
60	149	160	95	65	40.6	473
12	207	219	129	90	41.1	475
25	113	121	69	52	43.0	477
54	120	133	72	61	45.9	478
21	99	112	50	62	55.4	483
32	100	109	54	55	50.5	481
11	129	144	69	75	52.1	483
33	107	122	55	67	54.9	486
72	150	169	73	96	56.8	487
56	114	128	56	72	56.3	487
44	100	114	49	65	57.0	485
22	123	141	60	81	57.4	484
10	95	109	46	63	57.8	482
15	103	119	49	70	58.8	484
24	144	165	68	97	58.8	486
82	112	129	53	76	58.9	485
3	119	137	56	81	59.1	486
17	74	86	34	52	60.5	484
35	113	131	52	79	60.3	487
73	135	157	61	96	61.1	486
78	117	134	51	83	61.9	485
26	130	153	57	96	62.7	487
84	146	170	63	107	62.9	488
50	90	104	39	65	62.5	489
53	103	122	45	77	63.1	486
52	157	185	68	117	63.2	488
80	136	158	57	101	63.9	487
85	83	97	35	62	63.9	494
30	171	200	70	130	65.0	490
20	129	152	53	99	65.1	489
75	196	231	79	152	65.8	491
77	175	206	70	136	66.0	490
69	140	166	56	110	66.3	491
43	121	144	49	95	66.0	490
39*	161	191	64	127	66.5	491
34	95	112	37	75	67.0	490
51	113	134	44	90	67.2	493
45	96	114	36	78	68.4	495
28	201	237	76	161	67.9	493
31	132	156	50	106	67.9	493
29	130	155	48	107	69.0	492

* Before introduction of ion exchange

TABLE 13: APPROXIMATED SALTS, 1940 - 1948 AVERAGES (Continued)

Key No.	Sulphated Ash p.p.m.	Total Salts p.p.m.	Mineral Salts p.p.m.	Metallo-Organic Salts p.p.m.	Metallo-Organic Salts % Total	Conductivity-Ash c-ratio
65	.142	171	51	120	70.2	0.000498
76	64	78	23	55	70.5	481
57	103	145	42	103	71.0	493
46	98	120	34	86	71.7	495
64	71	87	24	63	72.4	497
42	124	152	42	110	72.4	496
62	142	172	47	125	72.7	498
5	136	168	46	122	72.6	496
41	131	159	44	115	72.3	500
14	132	159	43	116	73.0	500
16	126	156	40	116	74.4	500
83	82	101	25	76	75.2	500
6	113	140	34	106	75.7	500
55	121	152	35	117	77.0	502
37	164	204	47	157	77.0	502
8	132	175	40	135	77.1	508
4	191	223	60	173	77.6	497
7	119	148	33	115	77.7	504
63	141	175	39	136	77.7	504
68	244	305	68	237	77.7	501
23	117	148	30	118	79.7	509
18	123	156	31	125	80.1	506
71	87	111	22	89	80.2	509
86	71	90	17	73	81.1	507
66	102	129	24	105	81.4	513
1	98	125	22	103	82.4	510
13	147	188	33	155	82.4	510
2	87	110	19	91	82.7	512
27	152	195	33	162	83.1	508
9	160	207	31	176	85.0	508
90	143	186	27	159	85.4	509
47	151	198	22	176	88.9	524
39**	48	65	4	61	93.8	533
** After ion exchange						
95	154	170	40	130	76.5	497
94	126	158	32	126	79.7	508
91	171	220	42	178	80.9	509
96	245	312	55	257	82.4	509
93	135	174	25	149	85.6	509

(4) Reflectance, color and turbidity of sugars (Table 14). This table presents the relectances, color, and turbidity of the sugar solutions, and includes the averages, 1941 to date, as well as data for the 1945 campaign.

The reflectance was measured as usual by the Brice-Keane instrument. There is considerable indication that the data on the 1947 sugars for reflectance were systematically high. The cause of this error was found this year and the results are on a comparable basis with the years previous to 1947, and are essentially on a par with the 1946 data.

Color and turbidity were measured on a sugar solution containing 60 grams of sugar in a 100 cc. volume. Color was determined after filtration with asbestos and standard filtercel using a 10 cm. cell in an Aminco abridged spectrophotometer. The transmissions are calculated to - log t values and pointed off as whole numbers. Turbidity was measured by balancing the unfiltered against the filtered sugar solution and is also expressed as - log t units.

In addition to measurements of color and turbidity at the naturally occurring pH as reported in the table, they were also determined at a low pH, near 4.5, and at a high pH near 8.0. In the first instance a 2 cc. portion of one-hundredth normal hydrochloric acid was added before making the sugar soltuion to the 100 cc. volume and similarly at the other extreme 2 cc. of hundredth normal potassium hydroxide was added. The purpose was to get data on the buffer strength of the salts in the sugars and on the amphoteric color changes due to pH.

The change of color in sugar solutions with change in pH is a well known fact; yet one which is too often ignored and concerning which very little data have been published. In the (a) portion of Table 15 the data are grouped according to the initial color at the occurring pH. It can be seen that the higher the original color the greater the change of color with change in pH. The first two groups show only a small difference and one in the opposite direction from the general trend. This may be due to the difficulties in obtaining reliable color measurements where the color intensity is very low. The general averages show a proportional decrease in color on addition of the acid of 36% and an increase of color due to addition of alkali of 50%. The former corresponded to a pH drop of 2.00 pH units and the latter to a pH increase of 1.17 pH units.

On further examination of the total data it was also observed that the sugars of low initial pH lost more color on acidification than those sugars of high initial pH. However, the color increase on addition of alkali was essentially the same whatever the initial pH. The amount of the pH change produced by the acid and alkali additions was not correlated with the color change which means that to some degree the effect of the added chemical was independent of the pH change. In fact, other chemicals than those used might produce different results.

In the case of turbidity the results cannot be interpreted, as on the average the turbidity was increased by both the acid and alkali additions. Some individual sugars showed lower turbidities than the original especially on the acid side but the majority did not. It will be noted that the higher the initial turbidity the greater the change on addition of the reagents.

TABLE 14: REFLECTANCE, COLOR AND TURBIDITY OF SUGARS

Key No.	Reflectance Average 1941-48	Reflectance 1948 only	Color in Solution Average 1941-48	Color in Solution 1948 only	Turbidity in Solution Average 1941-48	Turbidity in Solution 1948 only
1	92.2	93.0	1.97	2.4	3.63	2.1
2A	---	94.2	---	2.6	---	2.7
2B	93.2	92.9	3.25	2.2	3.44	4.6
3	92.7	93.6	2.01	2.4	2.12	2.1
4	92.6	92.5	2.45	3.9	2.65	2.6
5	92.9	92.3	2.31	4.3	2.74	4.3
6A	---	93.2	---	6.1	---	3.0
6B	93.3	94.0	2.37	1.3	2.36	2.6
7	92.9	92.7	2.41	3.2	2.41	1.9
8	92.8	92.8	3.07	4.2	3.14	3.7
9	91.2	90.2	5.08	8.0	4.60	3.2
10	92.5	93.0	1.44	1.3	2.30	2.6
11	92.7	94.5	1.26	1.6	2.14	1.6
12	92.3	---	1.70	---	10.27	---
13	91.8	92.1	2.50	5.4	3.27	4.5
14	93.7	93.3	2.26	3.0	2.53	2.6
15	94.2	94.4	2.20	2.1	3.71	6.8
16	93.4	93.4	2.43	2.6	4.18	1.8
17	92.0	92.0	1.59	2.9	5.06	2.8
18	92.3	93.0	2.54	3.1	4.22	4.3
20	92.0	90.5	2.45	5.4	3.43	4.8
21	93.0	92.6	2.93	4.3	4.24	6.4
22	93.1	94.0	1.25	1.8	2.88	0.7
24	93.5	93.4	2.08	3.8	2.90	3.0
25	93.5	---	1.13	---	2.17	---
26	94.1	93.4	2.04	3.4	2.56	2.1
27	92.3	93.6	3.66	3.5	5.80	2.2
28	92.1	90.3	4.30	7.1	4.86	4.2
29	93.7	93.2	2.46	3.4	3.87	2.9
30	93.3	92.7	2.34	3.8	2.83	3.0
31	93.4	94.1	2.04	3.7	4.01	4.5
32	94.0	93.9	1.73	0.5	2.05	1.0
33	92.3	91.3	2.26	3.9	6.79	4.9
34	92.0	91.0	3.64	4.7	2.94	1.6
35	93.1	91.7	2.64	4.6	2.70	1.3
37	93.9	93.2	2.75	2.7	2.73	1.2
39	93.3	95.2	2.61	2.6	3.87	2.5
40	93.5	93.4	1.75	1.9	9.15	4.2
41	93.7	95.0	2.68	2.9	2.23	1.2
42	93.7	94.3	2.76	3.3	2.76	1.2
43	93.3	93.3	2.23	2.9	3.01	1.3
44A	---	92.0	---	3.0	---	2.7
44B	92.4	94.0	2.70	3.3	2.81	1.8
45	92.9	94.1	3.30	3.8	3.38	1.3
46	93.3	93.5	2.13	3.5	4.20	2.7
47	93.1	93.3	2.71	2.5	4.59	8.7
49	93.3	94.0	1.26	1.9	4.94	4.4
50	93.4	94.5	1.49	2.9	2.36	1.4

TABLE 14: REFLECTANCE, COLOR AND TURBIDITY OF SUGARS (Continued)

Key No.	Reflectance Average 1941-48	Reflectance 1948 only	Color in Solution Average 1941-48	Color in Solution 1948 only	Turbidity in Solution Average 1941-48	Turbidity in Solution 1948 only
51	91.4	---	3.60	---	5.00	---
53	93.4	91.6	2.29	4.0	4.06	2.3
54	93.9	94.5	1.70	3.2	7.83	2.0
55	92.1	91.4	2.76	6.2	5.28	16.0
56	93.3	93.8	1.66	3.4	2.06	1.4
57A	---	93.9	---	1.0	---	2.5
57B	93.8	93.7	2.29	3.4	3.11	2.2
59	94.1	93.7	1.41	0.9	1.98	2.0
60	93.1	92.9	1.39	1.6	2.84	6.0
61	93.0	91.5	2.51	4.5	7.77	4.7
62	92.9	92.9	1.88	1.3	3.10	2.2
63	92.6	92.9	2.65	3.0	4.71	12.5
64A	---	92.0	---	5.6	---	2.7
64B	92.8	93.3	2.63	3.8	3.13	1.2
65	93.1	93.4	1.59	1.0	3.24	2.2
66	93.5	94.3	1.46	0.1	3.68	5.5
68	93.4	---	1.80	---	2.97	---
69	91.8	92.1	2.51	6.3	3.13	2.7
71	93.1	94.2	3.36	2.9	4.01	2.6
72	94.1	95.0	1.03	0.0	2.26	1.7
73	93.8	94.3	1.80	0.6	4.90	4.3
75	93.2	92.8	1.51	2.2	6.19	4.4
76	93.5	93.7	2.78	4.1	3.30	3.5
77	92.9	92.2	3.26	1.1	4.24	3.9
78	92.4	92.0	3.24	3.9	4.74	3.7
79	93.5	93.6	2.24	3.7	6.16	6.9
80	92.6	92.1	3.34	3.3	2.64	1.2
82	93.7	93.9	2.58	1.9	2.45	0.9
83	92.8	92.2	2.58	4.7	3.00	3.2
84	93.4	92.9	1.74	3.5	3.43	1.5
85	---	92.9	---	4.1	---	2.2
86	---	91.1	---	6.7	---	5.6
90	94.4	92.9	0.62	0.0	2.23	0.7
91	88.0	86.9	3.73	4.9	6.78	6.4
93	91.3	90.2	5.20	5.5	5.40	3.2
94	91.6	87.8	3.59	3.5	4.20	3.2
95	91.5	93.1	4.86	3.2	3.78	1.7
91C1	---	90.0	---	3.9	---	4.4
91C2	---	89.4	---	1.9	---	2.3
1/Average	93.06	93.10	2.37	3.15	3.71	3.34

1/ Average includes only numbers for which both the 1941-48 average and the 1948 results are available; 69 factories in all. Numbers 90-95 not included in average.

Buffer strength or resistance to pH change could best be measured by electrometric titration to arbitrary acid and alkaline pH's but the procedure here used of making uniform additions of the reagents was successful in demonstrating the buffer effects of different amounts of ash in the sugars. The (C) section of table 15 presents the average data for different ash groups in terms of the change in pH produced by the acid and by the alkali and the total change. The trends are consistent except for the second value in the acid column, and it appears definite that (1) the lower the ash the larger the pH change and (2) the increases on the alkaline side are much smaller than the effects produced by the equivalent amount of acid. In the food industries the sugar is usually added to mixtures which are themselves very highly buffered and the sugar concentration used is often low so it is unlikely that the initial pH or buffer content of the sugar would significantly affect the pH of the product.

The data were also studied on the basis of varied ash in groups of sugars of similar initial pH. The effects of initial pH were not entirely consistent; but the general trend appeared to be that with increasing initial pH the decreases in pH that will be produced by the acid are greater and the increases due to additions of alkali are smaller. The total pH contrast between the acidified and the alkalized sugar solutions was smaller the higher the original pH. The general observation is that (1) pH is lowered more easily than it can be increased and (2) low ash sugar solutions may drop in pH by 0.5 pH unit lower than a high ash solution of the same initial pH.

It would be impracticable to present the complete data of this study; therefore, the three parts of Table 15 summarize the results.

(5) pH, Foaming and rating of sugars. (Table 16). Table 16 presents the 1941-1948 averages and the 1948 data on the pH of the sugar solutions (at 30 grams per 100 cc. volume), also foaming tests and the calculated formula rating percentages.

Year to year comparisons of data on color, pH, and foaming have never been satisfactory. A probable cause is unconscious changes in the exact technique used due to the varying skills of operators. While the comparisons between the different sugars agree from year to year the general level of all the values may be strikingly different. This year was the season to obtain generally high color, low pH, and excessive foaming. The color and foaming considerably affected the general level of the calculated ratings. As usual the comparisons between the sugars of the different factories are not greatly altered. It is this annual shifting of results which made it especially desirable to include the 1941-1948 averages which give a more exact comparison of the quality of the sugars of the various factories in values that are more accurate than any one year's results.

While the pH values are at a lower level than usual there is a wider spread between different sugars. The values should be especially accurate as determinations were made at two different periods and also to a degree were checked by the special readings after additions of acid and alkali. All data were in good agreement. In the report for the 1940 campaign (ACE-103) a comparison is made of white massecuite pH with the sugar pH. A similar study made on the current data yields almost identical results. Table 17 summarizes the new values and the 1940 results.

TABLE 15. EFFECTS OF ACID AND ALKALI ON COLOR, TURBIDITY AND pH

(A) Color

Group	Number	Color Means (-log t units) Low pH	Natural pH	Alkaline pH	Total Change
1. Color below 2.5	19	0.62	1.58	2.92	2.30
2. Color 2.5-3.5	18	2.05	3.15	4.22	2.17
3. Color 3.5-4.5	26	2.68	4.07	5.71	3.03
4. Color 4.5-5.5	10	3.16	4.94	7.82	4.66
5. Color over 5.5	10	4.71	6.72	10.59	5.88
General Average	83	2.37	3.72	5.59	3.22
(Average pH)	--	(4.70)	(6.70)	(7.87)	

(B) Turbidity

Group	Number	Turbidity Means (-log t units) Low pH	Natural pH	Alkaline pH
1. Turbidity below 1.5	16	3.75	1.15	4.37
2. Turbidity 1.5-2.5	19	2.75	2.00	3.84
3. Turbidity 2.5-3.5	21	5.09	2.81	5.59
4. Turbidity 3.5-4.5	13	6.92	4.20	7.57
5. Turbidity 4.5-6.5	9	11.57	5.43	10.83
6. Turbidity over 6.5	5	27.75	10.17	25.70
General Average	83	6.53	3.25	7.04

(C) pH

Total change in pH units versus ash concentration after additions of acid and of alkali respectively

Number Items	Sulphated Ash Range p.p.m.	Mean p.p.m.	Acidified 2cc 0.01 HCl pH decrease	Alkalized 2cc 0.01 KOH pH increase	Total pH change
7	-70	58	2.27	1.49	3.76
10	70-90	83	2.00	1.41	3.41
17	90-110	102	2.12	1.21	3.33
21	110-130	120	1.98	1.08	3.06
15	130-150	140	1.92	1.03	2.95
6	150-180	168	1.91	0.92	2.83
6	180 up	237	1.68	0.93	2.61

TABLE 16: pH, FOAMING TEST AND RATING OF SUGARS

Key No.	Solution pH		Foaming Test				Formula Rating Percentage	
			Maximum		Final			
	1941-48 Average	1948 only	1941-48	1948	1941-48	1948	1941-48	1948
1	6.93	6.90	100	116	80	92	95.2	94.7
2A	---	6.74	---	96	---	76	---	98.4
2B	7.19	6.50	100	102	80	78	95.3	95.3
3	7.11	6.78	104	128	80.5	84	95.3	92.7
4	7.20	6.64	108	98	82	79	93.3	93.8
5	7.43	7.12	103	112	81	82	95.2	90.2
6A	---	6.46	---	112	---	92	---	90.2
6B	7.08	6.38	105	92	82	86	95.7	99.9
7	7.22	7.04	101	116	78	76	95.6	93.2
8	7.24	7.12	108	132	80	84	93.4	88.4
9	7.39	7.72	96	94	78.5	76	89.2	86.0
10	7.26	7.10	108	128	83	84	95.8	94.1
11	7.25	7.02	105	122	84	90	96.2	96.6
12	6.51	---	98	---	77.5	---	87.9	---
13	7.09	6.61	101	104	86	100	93.4	90.0
14	7.34	6.96	105	132	84	92	96.4	91.6
15	6.82	6.35	117	108	85	84	94.2	93.6
16	7.04	6.78	106	120	82	87	94.6	94.3
17	6.99	6.39	98	100	77.5	80	96.0	94.6
18	7.15	7.22	97	92	80	84	94.2	95.0
20	7.11	6.88	98	104	83.5	80	93.8	87.4
21	6.83	6.25	103	96	85.5	84	93.3	90.9
22	7.07	6.96	111	148	83	86	95.5	92.9
24	6.98	6.83	101	100	80	81	95.6	93.9
25	7.08	---	105	---	85	---	95.9	---
26	7.05	6.70	106	124	83	100	96.9	92.1
27	7.44	7.81	105	108	79	76	90.6	94.8
28	7.04	6.79	110	108	87	96	88.9	82.8
29	7.00	6.90	114	160	86	88	94.2	87.5
30	7.19	6.94	126	160	85.5	84	91.9	85.2
31	6.95	6.53	103	100	85.5	90	95.0	94.2
32	7.05	6.65	103	108	80.5	80	97.7	99.8
33	6.81	6.28	118	120	94	94	89.9	87.8
34	6.84	6.78	103.5	108	81.5	82	93.0	90.6
35	7.00	6.50	126	146	89.5	98	92.2	86.7
37	6.88	6.75	113	160	86	96	94.2	89.5
39	7.12	6.64	104	92	82	76	94.3	100.8
40	6.77	6.13	102	110	81	84	90.3	90.6
41	6.95	6.79	108	120	83	82	95.3	96.1
42	7.08	6.79	116	128	84	84	93.9	93.7
43	7.34	7.34	108.5	120	81	82	95.0	94.1
44A	---	7.25	---	120	---	84	---	92.1
44B	7.09	6.96	104	88	80	76	94.3	98.5
45	6.98	6.58	102	110	80.5	82	94.5	95.8
46	6.88	6.26	101	96	81	78	95.6	96.1
47	7.19	6.97	109.5	80	82	72	93.2	95.4
49	6.78	6.09	98	84	76	78	95.2	98.2

TABLE 16: pH, FOAMING TEST AND RATING OF SUGARS (Continued)

Key No.	Solution pH		Foaming Test				Formula Rating Percentage	
			Maximum		Final			
	1941-48 Average	1948 only	1941-48	1948	1941-48	1948	1941-48	1948
50	7.00	6.71	108.5	128	82	88	96.8	94.9
51	6.84	---	113	---	87	---	89.1	---
53	6.69	6.47	100	108	79	78	95.3	90.3
54	6.54	6.25	97	102	80	80	93.7	97.2
55	6.80	7.14	97	86	80	84	93.0	82.8
56	6.88	6.72	107	160	81.5	92	96.5	89.0
57A	---	6.01	---	98	---	80	---	99.5
57B	6.58	6.03	99	90	80.5	80	97.0	97.3
59	6.70	6.19	119	140	85.5	84	93.1	90.8
60	6.65	6.47	117.5	128	87	92	93.8	91.0
61	6.53	6.25	99	104	78	76	90.3	86.5
62	6.72	6.52	103	108	80	76	95.4	95.6
63	7.12	7.17	98	84	78	76	93.8	91.3
64A	---	6.19	---	124	---	84	---	88.5
64B	6.97	6.27	110	108	84	80	94.6	95.5
65	7.06	6.88	123	120	84	84	93.3	95.1
66	7.06	6.50	107	106	83	86	96.5	98.7
68	7.05	---	109	---	85	---	93.6	---
69	6.99	6.68	115	128	82	84	91.2	86.0
71	7.07	6.90	109	110	87	90	93.6	96.0
72	6.99	6.89	118	196	87	96	96.0	89.5
73	7.01	6.83	104	96	82	76	95.3	99.2
75	7.13	7.02	108.5	116	87	92	92.9	90.4
76	7.06	6.28	99	110	80	82	96.6	93.9
77	7.12	7.02	119	140	85.5	84	90.5	89.3
78	7.21	6.82	94	88	77	72	93.8	93.1
79	6.81	6.48	106	160	86	112	92.6	85.4
80	6.94	6.60	115	112	85	88	91.2	92.1
82	7.06	6.81	116	128	80	80	93.3	95.3
83	6.90	6.62	121	124	90.5	84	93.3	89.6
84	6.97	6.64	131	172	93	96	91.9	83.6
85	---	6.30	---	112	---	84	---	92.9
86	---	6.38	---	104	---	84	---	86.8
90	7.63	7.68	86	78	70	67	101.9	101.3
91	7.51	7.73	97.5	80	77.5	72	85.0	85.4
93	7.21	6.92	102	104	82	84	88.3	87.9
94	7.15	6.90	103	110	82	84	91.2	87.7
95	6.85	6.39	132	156	100.5	104	85.7	88.6
91C1	---	6.60	---	72	---	72	---	94.0
91C2	---	6.55	---	76	---	68	---	96.5
1/Average	7.01	6.72	107.2	116.3	82.8	84.6	94.0	91.0

1/ Values averaged include only items for which both 1941-48 and 1948 figures are available. Nos. 90 and higher are not used.

TABLE 17: pH OF WHITE MASSECUITES VERSUS SUGARS

	Number Items	1948 Results pH White Massecuite Range	1948 Results pH White Massecuite Average	1948 Results pH Sugar Average	1940 Results pH White Massecuite	1940 Results pH Sugar Average
1.	14	6.9-7.6	7.26	6.26	7.0-7.6	6.3
2.	14	7.6-8.0	7.88	6.47	7.6-8.0	6.5
3.	15	8.0-8.4	8.25	6.75	8.0-8.4	6.7
4.	17	8.4-8.8	8.66	6.82	8.4-8.8	6.9
5.	12	8.8-9.2	9.10	6.98	8.8-9.2	7.2
6.	7	9.2-9.9	9.60	7.42	---	---

The relationship between pH of massecuite and sugar is not a constant amount; instead the higher the massecuite pH the greater the contrast between it and the sugar. For example, the difference in pH, or drop in pH, between massecuite and sugar in the above 1948 data are as follows; 1.00, 1.41, 1.50, 1.84, 2.12 and 2.18, respectively. It was thought that the trend evidenced in the comparison of thin and thick juice pH might be related to the above changes and the data were examined with this in mind. Table 18 summarizes the results using the pH behavior shown on concentrating thin juice to thick juice as a basis for grouping and averaging.

TABLE 18: pH CHANGES FROM THIN JUICE TO SUGAR

Group No.	Number Items	pH Thin Juice	pH Thick Juice	Change pH	pH White Massecuite	pH White Sugar	Change in pH Thin Juice	Change in pH Massecuite
1.	11	8.43	7.63	-0.80	7.42	6.31	-2.12	-1.11
2.	21	8.32	8.08	-0.24	7.94	6.56	-1.76	-1.38
3.	24	8.25	8.54	+0.29	8.41	6.71	-1.54	-1.70
4.	21	8.23	9.22	+0.99	9.08	7.03	-1.20	-2.05

The difference in the amount of pH change from thin juice to white sugar is striking; the stronger the tendency for thin juice to increase in pH on concentration, the smaller the net change from thin juice to sugar. This trend is partially compensated for by the greater change in pH from massecuite to sugar associated with increasing pH of the massecuite. Ten of the eleven factories of the first group are in the West coast area. This indicates that the more extreme tendencies for thin juice to drop in pH on concentrating is a characteristic of the beets of that area. The other three groups do not show regional segregation but there is a progressive increase in the proportion of nonSteffen factories until in the fourth group all but three of the 21 factories are nonSteffen.

The foaming test was carried out with slow stirring until the temperature reached 98° C. It was noted that the exact timing of the test was important and also the heating arrangement. The results reported are an average of two

tests made using different gas burners. One burner applied the heat intensely in a small area of the supporting wire-asbestos gauze while the other was more disperse and required a large flame to get the proper heating rate. The differences in maximum foaming were often considerable but the final foaming level was rarely different.

In preparing the solutions for color and pH measurements both with and without added acid and alkali it was noted that on some samples after shaking the foam persisted to different degrees and lengths of time. Notes were taken and a rough rating was made of this foaming tendency in cold solutions. The agreement with the foaming rates determined by boiling was excellent. It appears likely that a standardized stirring test in the cold might be developed for estimating the foaming characteristics of the sugars which could be more exactly duplicated by different operators.

The rating percentages were as usual based on sulphated ash, sulphites, color, and turbidity in solution, reflectance, and the maximum foaming point. The 1941-48 averages were calculated from averages of the grading criteria handled in the same way as the 1948 results. As already mentioned the generally lower ratings in 1948 are due to the higher color and foaming tests. In spite of the tendency for these latter values to be high some factories show a definite improvement in the rating percentage.

(6) Screening tests (Table 19). Screening tests for grain size distribution were performed in the usual manner using 100-gram portions of sugar which were aliquoted by use of a Jones riffle. The fineness modulus was again calculated by the method of Nees and gives a single rating value for grain size. The larger the value the coarser the sugar. The average modulus was identical with the 1947 sugars.

TABLE 19: SCREENING TESTS ON SUGARS

(A) Non-Steffen Sugars

Key No.	Percent Retained on U.S. Screens Nos. 20	30	40	50	60	70	80	100	Through No. 100	Total on 40 and 50	Fineness Modulus
4801	0.0	5.2	34.8	31.0	11.0	9.0	4.0	3.0	2.0	65.8	56.7
4803	0.0	1.7	21.3	31.5	14.5	14.0	7.5	6.5	3.0	52.8	35.4
4804	0.3	16.7	39.8	25.0	8.2	5.3	2.7	1.3	0.7	64.8	89.8
4805	0.0	2.5	24.2	31.9	13.9	13.9	6.6	5.0	2.0	56.1	40.1
4806A	0.0	3.5	21.0	31.0	15.0	14.0	7.0	6.0	2.5	52.0	38.1
4806B	0.0	2.0	23.5	34.0	14.5	12.5	6.5	4.5	2.5	57.5	39.7
4808	0.0	1.0	18.0	36.0	15.0	15.0	7.0	5.5	2.5	54.0	33.7
4809	0.1	5.6	28.3	31.3	13.4	10.8	5.0	4.0	1.5	59.6	50.5
4810	0.0	4.0	35.0	35.0	10.5	7.5	3.5	3.0	1.5	70.0	56.8
4811	0.0	0.1	18.4	41.0	14.5	11.0	5.5	5.5	4.0	59.4	34.3
4813	0.0	3.0	22.0	33.0	15.0	13.0	6.0	6.0	2.0	55.0	39.4
4814	0.0	2.5	28.5	38.0	14.0	9.0	4.5	2.5	1.0	66.5	47.8
4815	0.1	2.0	30.3	36.8	12.8	9.0	4.0	3.5	1.5	67.1	48.7
4816	0.0	0.5	16.0	43.0	18.0	13.0	5.5	3.5	0.5	59.0	35.7
4817	0.0	1.0	28.0	44.0	14.2	8.0	3.0	1.4	0.4	72.0	49.1
4818	0.1	5.0	33.7	30.0	11.2	9.0	5.0	4.0	2.0	63.7	54.2
4821	0.0	0.4	9.0	38.6	18.0	14.5	6.7	6.8	6.0	47.6	25.9
4822	0.0	1.5	21.5	37.5	14.8	11.5	5.4	5.3	2.5	59.0	38.5
4827	0.0	5.0	33.4	31.4	11.5	9.0	4.5	3.2	2.0	64.8	54.8
4832	0.0	0.3	18.7	43.0	13.0	13.0	5.0	4.5	2.5	61.7	36.2
4833	0.0	1.0	22.0	38.0	14.0	12.0	5.0	5.0	3.0	60.0	38.1
4834	0.0	6.5	40.5	32.0	10.0	6.0	3.0	1.5	0.5	72.5	68.7
4835	0.1	1.8	22.2	38.0	15.4	11.5	5.0	4.5	1.5	60.2	40.7
4839	0.1	6.5	32.4	28.5	10.5	11.0	5.5	4.5	1.0	60.9	55.1
4843	0.1	2.9	23.8	34.2	13.0	12.0	6.0	5.0	3.0	58.0	41.2
4844A	0.0	3.5	31.5	30.0	11.0	9.5	5.5	6.0	3.0	61.5	47.6
4844B	0.0	4.0	44.0	31.0	9.0	5.0	3.0	2.8	1.2	75.0	65.9
4845	0.0	0.2	19.0	40.0	16.6	12.4	5.8	4.0	2.0	59.0	35.8
4847	0.0	2.0	27.0	32.5	13.5	10.5	6.0	5.5	3.0	59.5	41.9
4849	0.0	2.5	25.0	28.0	12.5	12.0	7.5	6.5	6.0	53.0	37.2
4850	0.0	0.5	15.0	37.5	17.0	13.0	7.0	6.0	4.0	52.5	30.8
4854	0.0	0.5	18.5	43.0	15.0	11.0	5.0	4.5	2.5	61.5	36.6
4855	1.0	19.0	33.0	26.0	10.0	7.0	2.0	1.0	1.0	59.0	88.5
4859	0.0	3.0	35.0	34.0	13.0	7.5	3.5	2.5	1.5	69.0	54.8
4861	0.0	2.0	30.0	37.5	13.0	9.5	4.5	2.0	1.5	67.5	49.0
4863	0.2	12.5	39.6	27.7	9.5	6.5	2.5	1.2	0.3	67.3	80.3
4866	0.2	2.8	16.0	25.5	16.0	16.5	9.5	8.0	5.5	41.5	29.5
4869	0.1	0.8	24.2	45.5	15.0	8.5	3.5	2.0	0.5	69.7	39.9
4873	0.0	1.0	17.5	29.5	16.5	15.5	8.5	7.5	4.0	47.0	30.1
4876	0.0	1.0	31.0	42.0	13.0	8.5	2.5	1.5	0.5	73.0	55.5
4880	0.0	2.0	30.0	36.5	13.0	10.5	4.0	3.0	1.0	66.5	48.5
4882	0.0	1.0	22.5	29.0	13.0	13.5	8.0	8.0	5.0	51.5	33.1
4885	0.0	2.5	28.0	33.5	12.0	10.5	5.5	4.5	3.5	69.0	44.1
4886	0.3	1.7	30.0	39.0	12.5	8.5	3.5	3.5	1.0	69.0	49.6
Average	0.1	3.3	26.4	34.6	13.3	10.7	5.2	4.2	2.2	61.0	46.54

TABLE 19: SCREENING TESTS ON SUGARS (Continued)

Key No.	Percent Retained on U.S. Screens Nos. 20	30	40	50	60	70	80	100	Through No. 100	Total on 40 and 50	Fineness Modulus
4891	6.0	39.0	35.0	14.0	3.0	2.0	0.6	0.1	0.3	49.0	169.4
4891C1	2.0	20.0	37.0	25.0	8.0	4.0	2.0	1.0	1.0	52.0	99.9
4891C2	8.0	26.0	33.0	20.0	6.0	4.0	1.5	1.0	0.5	53.0	127.6
4893	1.0	10.0	32.0	28.5	10.0	10.5	4.0	2.5	1.5	60.5	64.7
4894	0.2	5.3	31.0	34.5	13.0	9.0	4.0	2.0	1.0	65.5	55.8
(B) Steffen Sugars											
4802A	0.0	0.7	18.4	29.5	14.5	15.0	8.5	8.0	5.5	47.9	28.6
4802B	0.0	3.5	39.0	30.5	11.0	9.0	4.0	2.0	1.0	69.5	58.7
4807	0.0	1.5	24.5	33.0	13.0	10.0	6.0	7.0	5.0	57.5	37.7
4820	0.0	3.0	37.0	35.0	10.0	7.5	3.0	3.0	1.5	72.0	57.1
4824	0.1	0.8	22.1	43.0	16.0	9.0	4.0	3.0	2.0	65.1	41.4
4826	0.1	1.9	20.3	32.9	14.8	12.5	7.5	6.0	4.0	53.2	35.4
4828	0.0	1.0	24.0	42.0	16.0	9.0	4.0	2.5	1.5	66.0	43.4
4829	0.0	1.0	24.0	41.0	13.5	10.5	4.0	4.0	2.0	65.0	42.0
4830	0.1	4.1	32.8	31.5	11.0	9.0	4.5	4.5	2.5	64.3	51.9
4831	0.0	0.5	22.0	32.0	13.0	12.5	7.5	7.5	5.0	54.0	33.3
4837	0.0	0.5	14.5	32.0	17.0	14.5	7.5	7.5	6.5	46.5	27.4
4840	0.0	0.1	11.9	46.0	19.5	12.5	5.0	3.0	2.0	57.9	32.6
4841	0.0	0.3	14.7	39.0	16.0	12.0	7.0	7.0	4.0	53.7	30.4
4842	0.0	0.7	15.3	34.0	15.0	12.0	7.0	9.0	7.0	49.3	28.3
4846	0.0	0.5	25.0	45.5	14.0	9.0	3.0	2.5	0.5	70.5	45.3
4853	0.2	2.8	27.5	41.8	11.7	8.0	4.0	3.0	1.0	69.3	50.0
4856	0.0	2.0	31.5	41.0	12.5	7.0	3.0	2.0	1.0	72.5	52.7
4857A	0.0	0.3	19.7	42.0	17.0	11.5	5.5	3.0	1.0	61.7	38.1
4857B	0.0	0.7	28.8	43.5	14.0	8.0	3.0	1.5	0.5	72.3	49.0
4860	0.0	1.0	19.5	34.0	14.5	12.5	7.5	6.0	5.0	53.5	33.2
4862	0.0	5.0	35.0	30.0	10.5	9.5	4.2	3.8	2.0	65.0	55.7
4864A	0.0	1.2	32.8	35.0	13.0	10.0	4.0	2.5	1.5	67.8	49.2
4864B	0.0	0.8	27.2	31.0	14.0	12.0	7.0	5.0	3.0	58.2	39.4
4865	0.0	2.0	26.0	34.0	13.5	10.0	6.0	5.5	3.0	60.0	41.5
4871	0.0	1.0	19.0	37.0	15.0	12.0	6.0	5.0	5.0	56.0	34.3
4872	0.0	0.8	24.2	45.5	15.0	8.5	3.5	2.0	0.5	69.7	45.3
4875	0.0	2.5	42.0	33.5	10.5	7.5	2.5	1.0	0.5	75.5	62.8
4877	0.0	3.2	36.8	38.0	11.0	6.0	2.0	2.0	1.0	74.8	59.8
4878	0.0	1.0	27.0	37.0	14.0	10.5	5.0	4.0	1.5	64.0	43.3
4879	0.0	1.0	10.0	33.0	18.0	16.0	9.0	8.0	5.0	43.0	24.5
4883	0.2	1.8	27.0	44.7	12.7	7.8	3.0	2.0	0.8	71.7	49.7
4884	0.0	3.0	29.5	39.5	13.5	8.0	3.5	2.3	1.7	69.0	51.2
4890	1.5	10.0	29.5	30.0	13.0	8.0	4.0	2.5	1.5	59.5	64.0
4995	0.2	4.3	28.0	33.5	12.0	9.0	5.0	4.5	3.5	61.5	47.8
Average	0.0	1.6	25.3	37.2	13.9	10.2	5.0	4.2	2.6	62.5	42.91

SUMMARY

Besides the tabulations of the operating data are given the long term quality of beets at the different factories; the calculated nonsugars percentage of beets in the diffusion juices and final molasses; the calculated nonsugars as percentage of sucrose in diffusion juices, white massecuites and final molasses, the percentage of elimination of nonsugars by processing; and the sucrose-nonsugar ratios expressing the melassigenic effect of the residual nonsugars.

In the presentation of the data on sugar quality are given the long-term averages for the factories as well as the 1948 results. There are also extra studies of the effects of uniform additions of acid and alkali on the color, turbidity, and pH of sugar solutions. The latter is shown to indicate buffer strength of the sugar ash. It is further suggested that a foaming test might be developed for cold measurement of this characteristic of different sugars. Other discussions include the relative of massecuite purity to ash in sugar; and the relation of the conductivity-ash c-ratio with the proportion of the metallo-organic salts.

PART II

BIOLOGICAL STUDIES OF SUGARS

By H. H. Hall and Dorothea J. Teunisson

The sugars were again studied in two ways for their biological quality. The presence and numbers of thermophilic and mesophilic bacteria and of yeasts and molds were determined for each sample since these organisms might influence the desirable characteristics or keeping quality of foods. The samples were also examined to determine the relative amounts of substances which stimulate the growth of yeasts in sugar solutions. The latter examination should help to determine the suitability of the sugars for use in the manufacture of beverages. The same identification numbers of the samples have been used in Part II as were used in Part I.

EXAMINATION FOR MICRO-ORGANISMS

The methods described in the Methods of Analysis of the Association of Official Agricultural Chemists, 6th. Edition, 1945, pp. 754-755, were used to examine the samples for the detection of thermophilic "flat sour" bacteria, and for the detection of thermophilic anaerobes not producing and for those producing hydrogen sulphide. Except for the latter two types, the modified media described in last year's report were used.

The presence and numbers of mesophilic organisms were again determined by weighing 20 grams of sugar aseptically into a sterile 150-ml. Erlenmeyer flask marked to indicate 100 ml. Sterile distilled water was then added to this mark. After the sugar was dissolved, 5 ml. were distributed equally into 5 plates, and the same medium used for the detection of thermophilic aerobic bacteria was added, and another 5 ml. were distributed into 5 plates to which standard wort agar was added for the detection of the presence and numbers of yeasts and molds. The cultures were incubated at 30° C. The mesophilic bacteria were studied after 72 hours of incubation, and the yeasts and molds after 5 days.

For ready reference, the bacterial standards that have been adopted for canning-grade sugars based on the permissible number of thermophilic bacterial spores contained in 10 grams of sample are presented:

Total aerobic thermophilic spores shall not exceed 125 per 10 grams of sugar.

Aerobic flat sour spores shall not exceed 50 per 10 grams of sugar.

Anaerobic sulfide spoilage spores shall not exceed 5 per 10 grams of sugar.

Anaerobic hard swell spores shall not be present in more than 4 (66.6%) of the 6 tubes of medium inoculated with the test sample.

Standards have not been established for mesophilic organisms, although for the dairy and beverage industries it has been suggested that the total plate count should not exceed 100 organisms per gram of sugar and almost complete

freedom from yeasts and molds is required. The results of the examination of the samples for micro-organisms are recorded in table I.

Eight of the 83 samples or 10.4% did not pass the standards for canning-grade sugar. Four contained an excessive total number of anaerobic thermophilic bacteria, 7 too many aerobic flat sour spores, and one contained 10 sulfide spores per 10 grams of sugar. Three of these samples (Nos. 4855, 4862, and 4866) contained an excess of both total and flat sour anaerobic thermophilic bacteria. Seven samples contained more than the allowable number of total mesophilic bacteria. Only 2 of these (Nos. 4813 and 4866) were also in the group which did not pass canning-grade standards. No yeasts were found in 68 of the 83 samples. Of the 15 samples from which yeasts were cultured, 4 contained only 1 per gram of sugar, 5 contained 2 per gram, three 3 per gram, and one 9 per gram. Only 3 samples showed an excessive amount of mold contamination.

EXAMINATION FOR YEAST-GROWTH-PROMOTING SUBSTANCES

Composite samples were again examined for the relative freedom from yeast-growth-promoting substances. The methods used for this test have been reported in several campaign studies, such as Mimeographed Circulars AIC-29 (1942) and AIC-62 (1943). The results of this study are given in table II. The yeast inoculum multiples ranged from 1.1 to 32.5, the average being 9. Forty-five samples or 54.2% had multiples smaller than this average. All of the sugars examined are considered to be within safe limits for the use in the manufacture of beverages.

TABLE I. BACTERIOLOGICAL EXAMINATION OF 1948 SUGARS

Sample No.	Thermophilic Bacteria: Aerobes: Total Count Per 10 Gm.	Thermophilic Bacteria: Aerobes: Flat Sour Per 10 Gm.	Thermophilic Bacteria: Anaerobes: Sulphide Spores Per 10 Gm.	Thermophilic Bacteria: Anaerobes: Hard Swell % Tubes With Growth	Mesophilic Organisms: Aerobic Bacteria: Total Per 1.0 Gm.	Mesophilic Organisms: Aerobic Bacteria: Acid-Forming Per 1.0 Gm.	Mesophilic Organisms: Yeasts: Total Per 1.0 Gm.	Mesophilic Organisms: Molds: Number Colonies Per 1.0 Gm.
4801	65	20	0	0	29	10	0	0
4802A	45	0	0	0	15	4	0	0
4802B	50	0	0	0	16	15	0	0
4803	0	0	0	0	13	7	0	3
4804	0	0	0	0	0	0	0	0
4805	0	0	0	0	3	2	9	0
4806A	20	10	0	0	16	5	2	0
4806B	10	0	0	0	1	0	0	0
4807	0	0	0	0	17	6	3	0
4808	0	0	0	0	2	1	1	1
4809	70	65	0	16.7	63	54	2	0
4810	0	0	10	50	13	10	1	0
4811	0	0	0	0	3	0	0	0
4813	80	55	0	0	165	140	2	0
4814	5	5	0	0	10	6	0	0
4815	15	10	0	0	3	0	2	1
4816	0	0	0	0	2	2	2	0
4817	5	0	0	0	2	2	0	0
4818	125	15	0	0	14	2	0	4
4820	20	20	0	0	238	210	0	0
4821	0	0	0	0	4	3	2	0
4822	5	0	0	0	11	11	3	0
4824	5	5	0	0	17	11	1	0
4826	20	5	0	0	2	1	0	1
4827	0	0	0	0	4	4	0	6
4828	35	25	0	0	115	90	0	3
4829	10	10	0	0	3	3	1	2
4830	5	5	0	0	10	7	0	1
4831	0	0	0	0	10	8	0	0

TABLE I. BACTERIOLOGICAL EXAMINATION OF 1948 SUGARS (Continued)

Sample No.	Thermophilic Bacteria: Aerobes: Total Count Per 10 Gm.	Thermophilic Bacteria: Aerobes: Flat Sour Per 10 Gm.	Thermophilic Bacteria: Anaerobes: Sulphide Spores Per 10 Gm.	Thermophilic Bacteria: Anaerobes: Hard Swell % Tubes With Growth	Mesophilic Organisms: Aerobic Bacteria: Total Per 1.0 Gm.	Mesophilic Organisms: Aerobic Bacteria: Acid-Forming Per 1.0 Gm.	Mesophilic Organisms: Yeasts: Total Per 1.0 Gm.	Mesophilic Organisms: Molds: Number Colonies Per 1.0 Gm.
4832	0	0	0	0	7	5	0	3
4833	10	10	0	0	135	113	0	0
4834	70	0	0	0	20	9	0	1
4835	50	5	0	0	3	1	0	0
4837	0	0	0	0	17	9	0	0
4839	0	0	0	0	7	3	1	0
4840	0	0	0	0	5	5	3	3
4841	25	20	0	33.3	20	14	0	0
4842	15	15	3	0	14	9	0	1
4843	0	0	0	0	4	3	0	1
4844A	5	0	0	0	4	4	0	1
4844B	25	10	0	0	54	49	0	1
4845	45	0	0	0	3	1	0	1
4846	0	0	0	0	0	0	0	0
4847	460	435	0	16.7	16	16	0	0
4849	5	5	0	0	21	15	0	1
4850	10	10	0	0	8	3	0	5
4853	0	0	0	0	19	14	0	0
4854	20	0	0	0	8	5	0	0
4855	140	130	0	0	17	10	0	3
4856	5	5	0	0	23	9	0	0
4857A	0	0	0	0	16	14	0	2
4857B	0	0	0	0	147	110	0	2
4859	10	10	0	0	1	1	0	2
4860	0	0	0	0	3	1	0	28
4861	0	0	0	0	9	9	0	42
4862	240	225	0	0	5	0	0	1
4863	5	0	0	0	13	10	0	8

TABLE I. BACTERIOLOGICAL EXAMINATION OF 1948 SUGARS (Continued)

Sample No.	Thermophilic Bacteria: Aerobes: Total Count Per 10 Gm.	Thermophilic Bacteria: Aerobes: Flat Sour Per 10 Gm.	Thermophilic Bacteria: Anaerobes: Sulphide Spores Per 10 Gm.	Thermophilic Bacteria: Anaerobes: Hard Swell % Tubes With Growth	Mesophilic Organisms: Aerobic Bacteria: Total Per 1.0 Gm.	Mesophilic Organisms: Aerobic Bacteria: Acid-Forming Per 1.0 Gm.	Mesophilic Organisms: Yeasts: Total Per 1.0 Gm.	Mesophilic Organisms: Molds: Number Colonies Per 1.0 Gm.
4864A	0	0	0	0	13	11	0	1
4864B	0	0	0	0	11	7	0	6
4865	20	10	3	0	6	4	0	2
4866	190	115	0	0	125	100	0	2
4869	10	10	0	0	18	15	0	95
4871	0	0	0	0	8	4	0	0
4872	0	0	0	0	6	3	0	0
4873	20	20	0	0	1	1	0	1
4875	10	5	0	0	19	14	0	1
4876	25	10	0	0	1	1	0	1
4877	10	10	0	0	49	43	0	1
4878	5	5	0	0	19	8	0	0
4879	10	5	0	0	20	9	0	2
4880	10	10	0	0	3	2	0	0
4882	25	20	0	0	13	9	0	3
4883	5	0	0	0	3	1	0	2
4884	35	25	0	0	7	5	0	0
4885	65	65	0	16.7	10	9	0	0
4886	15	10	0	16.7	9	4	0	2
4890	15	0	0	0	2	0	0	1
4891	0	0	0	0	138	4	0	2
$4891C_1$	5	5	0	0	9	5	0	0
$4891C_2$	10	10	0	0	8	1	0	0
4893	25	20	0	0	5	4	0	2
4894	25	0	0	0	13	4	0	2
4895	10	10	5	0	9	4	0	0

TABLE II. - RANKING OF SUGAR SAMPLES COLLECTED DURING 1948 CAMPAIGN ON BASIS OF RELATIVE FREEDOM FROM YEAST GROWTH-PROMOTING SUBSTANCES

Sample No.	Rank	Yeast-Inoculum Multiple	Sample No.	Rank	Yeast-Inoculum Multiple
4871	1	1.1	4873	25	8.5
4842	2	1.5	4802B	26	8.7
4890	2	1.5	4806B	26	8.7
4857A	3	2.8	4886	27	9.1
4859	4	3.2	4805	28	9.3
4876	4	3.2	4830	29	9.4
4894	4	3.2	4865	29	9.4
4864B	5	3.4	4833	30	9.8
4891 C_2	5	3.4	4814	31	10.0
4835	6	3.6	4816	31	10.0
4857B	6	3.6	4845	31	10.0
4846	7	3.8	4877	31	10.0
4849	8	4.3	4854	32	10.2
4879	9	4.5	4826	33	10.4
4817	10	4.7	4831	33	10.4
4844B	11	4.9	4837	33	10.4
4860	11	4.9	4807	34	10.6
4844A	12	5.3	4820	35	10.8
4891 C_1	12	5.3	4855	35	10.8
4803	13	5.5	4840	35	10.8
4872	14	5.7	4895	35	10.8
4802A	15	5.8	4832	36	11.1
4827	16	6.0	4853	36	11.1
4829	17	6.2	4804	37	11.3
4864A	17	6.2	4880	37	11.3
4834	18	6.8	4810	38	11.5
4841	18	6.8	4863	39	11.9
4806A	19	7.2	4818	40	12.1
4828	19	7.2	4809	41	12.6
4847	19	7.2	4866	41	12.6
4875	19	7.2	4869	41	12.6
4885	19	7.2	4821	42	13.0
4843	20	7.5	4822	43	13.2
4811	21	7.7	4884	43	13.2
4878	22	7.9	4815	44	14.3
4856	23	8.1	4808	45	14.9
4824	24	8.3	4862	46	15.5
4839	24	8.3	4850	47	17.9
4882	24	8.3	4893	48	19.8
4883	24	8.3	4861	49	23.4
4891	24	8.3	4801	50	32.5
4813	25	8.5			